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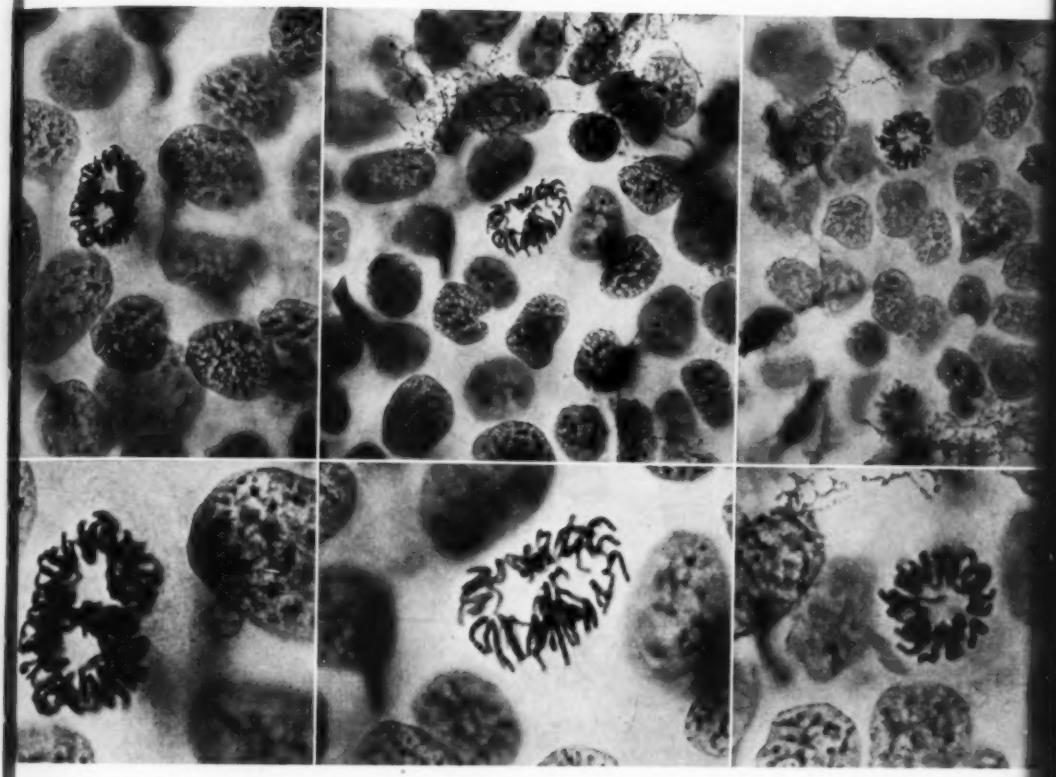

SALAMANDER CHROMOSOMES—POLYPLOID AND NORMAL

(SEE PAGE 379)

Calvin B. Bridges

Population Policy for the U. S.

The Dionne Quints Grow More Alike

Eugenic Views of a College Student

Chromosome Doubling in Cereals

VOLUME 30 SEPTEMBER, 1939 NUMBER 9

The American Genetic Association

An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

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CALVIN B. BRIDGES

Jan. 11, 1889 - Dec. 27, 1938

PERSONAL RECOLLECTIONS OF CALVIN B. BRIDGES

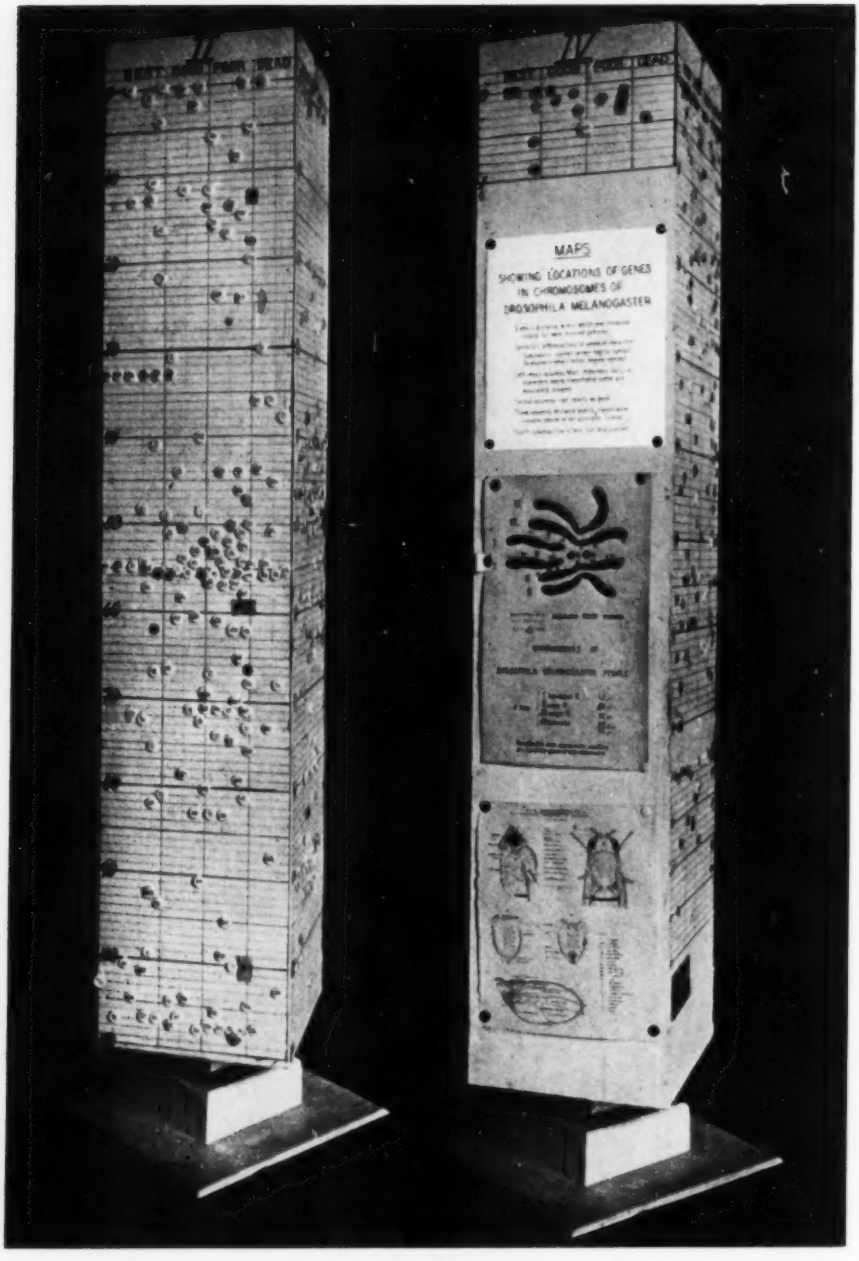
MY first contact with Bridges was when, as an undergraduate at Columbia University, he attended a course that I gave in Zoology and one in Embryology in 1909. After graduating in 1912 he continued his studies there, taking my course in experimental zoology which was in large part devoted to the rapidly growing field of Genetics with emphasis on the chromosome mechanism of heredity. The subject appealed to him and he wrote his doctor's thesis on "Non-disjunction as Proof of the Chromosome Theory of Heredity." In 1915 I received a grant from the Carnegie Institution of Washington to carry on investigations in heredity. Bridges and Sturtevant were appointed to undertake independent research work. For twelve years we three worked together in a small room in the Zoological Department of Columbia University. As the work on *Drosophila ampelophila* (as the vinegar fly was then called) became widely known, a succession of international fellows joined us, as well as some of the more advanced graduate students and fellows of Columbia University. It was not unusual for six of us to carry on in this small room; the only space at our disposal. Those were the days when bananas were used as fly food and in one corner of the room a bunch of bananas was generally on hand, —an adjunct to our researches which interested other members of the laboratory in a different way. As there were no incubators, a bookcase and a wall case were rigged up with electric bulbs and a cheap thermostat, which behaved badly at times, with consequent loss of cultures. The use of milk bottles came into the program at an early date, but where they came from was not known, or at least not mentioned. At a later date we were bold enough to ask for a case of new bottles.

This picture of the conditions under which we worked is not intended to suggest that we were handicapped. On the contrary, our proximity to each other led to cooperation in everything that went on. The discovery of a new mutant was immediately announced, and its location in the gene chain anxiously awaited. I have since wondered whether the elaborate set up of modern laboratories has all the advantages on its side. At any rate I doubt whether the modern students with all their equipment and assistance get as much joy out of their work as we had with our primitive set-up.

Contributions to Technique

The improvements that have gradually evolved since then have been to a large extent the outcome of Bridges' unusual inventive faculty. The hand lens was replaced by a binocular microscope of his designing; the wall cases have been supplemented by incubators with fans and expensive regulators; the banana has given place to a synthetic medium consisting of agar agar, corn-meal, molasses, and yeast. Even the symbols by which the Drosophila mutant races are named are in large part attributable to Bridges' interest in a suitable nomenclature. I recall one instance in which invention went too far. In order to save space in the incubators Bridges drew a plan for a milk bottle with a square base. But they were so closely packed that when the room temperature approached the lethal degree, the heat generated in the bottles went over the top. Unwilling to give up the new bottle Bridges got a large augar and bored holes through the carefuly prepared insulated walls of the incubator.

Bridges had his own system of bookkeeping. The data were often filed on bits of scrap paper, but it was almost uncanny to see how quickly he could find any information that was called for. He has left hundreds of cards, carefully filed, which contain all the data collected in this laboratory relating to each mutant



THE "TOTEM POLE"

Figure 1

One of the more picturesque of Bridges' numerous inventions to speed the genetic study of Drosophila was the "Totem Pole." This was an elongated box with one side devoted to each of the four chromosomes. The enameled pins were labelled with gene-symbols.

or aberration. Many of these data have never been published, and it is doubtful now if anyone will ever assemble them for publication. These data were used, however, in the calculation of loci and description of mutants and aberrations, in DIS 9, which appeared shortly after Bridges' death. This issue of *Drosophila Information Service* was one of the last things on which Bridges worked, and in it, fortunately, he brought down to date practically all his work in statistical genetics.

The "Totem Pole"

In this connection and as a correction if I have given a false impression I must describe what I call the "Totem Pole." Here all the information known with respect to the location of the genes in the chromosomes can be seen. The totem pole is a tall box (Figure 1). Each of the four chromosomes occupies one side. A series of horizontal lines runs across each face of the four vertical lines. White enamel thumb tacks carry the abbreviated symbols of the mutant type. These thumb tacks (or mutants) are moved from right to left according to the usefulness of the mutant, and up or down as the gene becomes more accurately located. At a glance one sees how far the location of all the genes has been worked out. Some remain on the right side because they were lost before accurate data were obtained, or because they were too poor in viability or phenotype to permit accurate location.

The construction of the genetic maps of *Drosophila melanogaster* (as it is now called) occupied a large part of Bridges' time for twenty years. Their construction was by no means a routine job. On the contrary some of the methods that he worked out, such as the application of the method of balancing the weaker classes, have come into general practice where greater accuracy is called for. Moreover in the working up of the material, in order to use it for particular problems in location of the genes, Bridges was always on the lookout for unusual or exceptional situations, and some of his important discoveries trace back to his acuteness in detecting exceptions. He was fertile in inventing methods leading to interpretation of novel situations.

Bridges' papers are models of scientific writing because they are clear and compact, due to his extreme carefulness in arrangement of material. In contrast to the apparent slowness with which he built up his scientific writing his procedure when he had a paper to give before a society was to put it off until the last minute and to work over it sometimes up to the last moment before delivery. Nevertheless his exposition was always excellent because he had mentally a clear idea of what he was about to say.

Between the year 1916, when Bridges' first important paper appeared on nondisjunction, and 1938 when he was working on a thorough-going revision of the salivary chromosome maps, he published more than 50 papers not including the annual reports to the Year Book of the Carnegie Institution, in which brief summaries of the work in progress are given. These reports give a general picture of the steady advances in Bridges' research work and include a great deal that has not been included in subsequent publications. Much of this was left for later working over. Nevertheless, although a great many of the data were necessarily omitted, these reports suffice to cover a good part of the work in progress and are invaluable to workers in the field of Drosophila genetics.

The Salivary Gland Chromosomes

A review of Bridges' scientific achievements will appear elsewhere, but his latest work on the salivary chromosomes should be recalled here, since the JOURNAL OF HEREDITY was the first journal to undertake the expensive and difficult task of reproducing, in excellent form, his maps of the chromosomes of *Drosophila melanogaster*. These maps are now standard all over the world. During the past year, 1938, Bridges continued the revision of the maps of the salivary chromosomes; that of the *X*-chromosome has been published in the JOURNAL OF HEREDITY, January, 1938. During the

summer of 1938 he nearly finished the right half of the second chromosome in collaboration with his son Philip, who is now putting it into shape for publication. He intended to leave the left half of that chromosome until the revision had extended to the other chromosomes because he had found that this half probably contains a number of "repeats," i.e. sections of duplicating parts. This idea is the last of many new contributions that Bridges made to the "higher Mendelism" and may prove of unusual interest in the future development of genetics.

The original discovery of the banded nature of the giant salivary chromosomes of diptera goes back to Balbiani's record in 1881. But the regularity of the sequences of the bands, the union of homologous chromosomes in pairs, and distinction of regions that stain and those that do not stain was reported in 1933 by Heitz and Bauer.

Painter, also in 1933, using *Drosophila melanogaster* material, contributed the all-important proof that there is a close correspondence between the sequence of the banding of the chromosome and the sequence of the genes as determined by genetic theory and practice. Without the already existing information as to the position of the genes in definite chromosomes it would have been impossible to establish this relationship, although Painter and Muller had already in 1929 laid the basis for comparisons of this kind by demonstrating that certain genetic translocations could be visibly detected as such in the chromosomes involved in such transfers and losses.

It became increasingly important after Painter's comparisons between the genetic and the salivary maps that identification of the bands be extended to the limit of microscopic vision in order to determine more definitely the relation of individual bands to the loci of the genes, since the determination of the correspondence between the sequence of the genes and that of the bands does not tell us whether there is an identity between them. Most of the bands are faint ones while some of the darker bands are double, etc. For this kind of work Bridges was eminently fitted. His eyesight was unusually acute but he did not depend on this alone and spent much time in a study of the best methods of illumination, the best combination of lenses, and the most suitable staining and preserving technique to bring out the fainter bands. As a result his new maps more than double the number of the previously known visible bands. He was also interested in the problem as to whether the stretching of the chromosome, when the nucleus is burst under pressure, may introduce artifacts. It is unfortunate that he died when in the midst of this detective work, but his methods will enable others to take up the story where he left off.

Bridges was a very friendly person. He was simple and unaffected and always helpful to anyone who came to him for advice. In the course of twenty years he was largely instrumental in building up stocks of Drosophila in which mutant genes of each chromosome are spaced so that they can be used as markers for each chromosome. These stocks are especially useful in studying crossing over, translocation and other special problems. More than 900 separate stocks are carried at present. Many of them have been distributed to investigators all over the world. Bridges spent much thought and time in building up this material and distributed it freely without even claiming credit from others for its use. In fact, one of his most admirable traits was his freedom from priority claims of any kind. His death is a serious loss to genetics and to his many friends.

—T. H. Morgan

GENETICS OF QUINTUPLETS

II. Trends of Growth in the Dionne Quintuplets

JOHN W. MACARTHUR
Department of Biology, University of Toronto
and
ALLAN ROY DAFOE
Callander, Ontario

THIS is a story of the five little Dionnes and how they grew in weight and stature. Previous papers by the Dafoes[4,5,6] have told how the tiny premature babies had at 40 months of age all but overtaken the average normal child in physical development.

The present account views their growth up to the fifth birthday from various other aspects. It shows how very unlike the five were in their weights at and shortly after birth, and how they have since grown — not more different, but more and more alike both in weight and in stature. In all these changes they have followed the trends characteristic of identical twins, and they have become (as they will in all probability now remain) at least as much alike in these respects as are so many pairs of identical twins of a corresponding age. It is, of course, to be recalled again that monozygotic twins are not really identical in size any more than they are in their finger prints[16] or other quantitative characters[7,24,29,30,37]. They are *merely far more similar* than fraternal (dizygotic) pairs.

The Quints have attained normal weights and heights

As compared with the average single-born female child the Quints at their birth were decidedly undersized. This is attributed to at least three special causes: (1) they were approximately two months premature, (2) they belonged to a set of five (or six), and (3) they were evidently derived from a single zygote (see this JOURNAL, September, 1938). The action of the first factor is obvious; moreover the data from multiple birth sets in man[7] and in animals[34] proves clearly that the young are individually smaller when an unusually large number are gestated together; and finally, "identicals" owing both to their manner of origin and to the peculiar imbalances of their intrauterine nutritive supplies (third circulation, etc.), are known to be more often seriously handicapped in the prenatal period than are fraternals[24,30,37].

All of these handicaps have, however, been overcome in the Quintuplets by an especially rapid growth (Figure 3). Since soon after their third birthday they have exceeded the average single born girl in weight, and they are now rapidly approaching the average height. Both their heights and weights are well within the "normal" range, and each, even the smallest, Marie, has probably attained the size and body build expected in this particular family of children.

The Quints become more alike in weight and in height

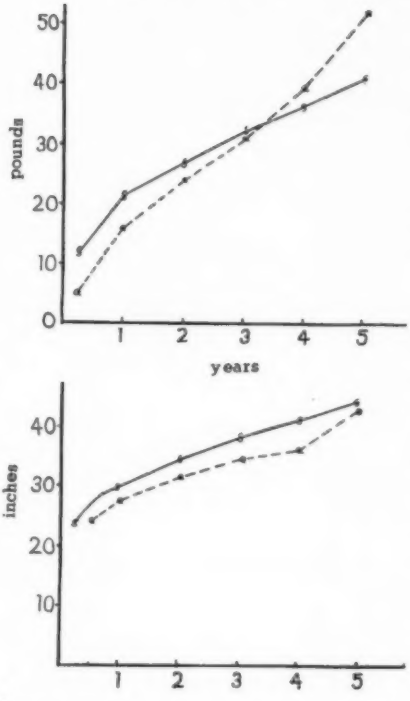
At birth the weights of the Quintuplets were: Marie, 31 ounces, Emilie 35, Cecile 37, Annette 44, and Yvonne 46. The difference between any two of them may be expressed as a percentage of the average of the two weights; for instance the pair differences in weight at birth ranged from only 2 ounces (4.4 per cent), between Yvonne and Annette, to a maximum of 15 ozs. (39 per cent), between Yvonne and Marie. The average difference for all the ten possible pair-

EMILIE ANNETTE YVONNE CECILE MARIE

THEIR FIFTH BIRTHDAY

Figure 2

The world has watched the amazing development of the Dionne Quintuplets, who have added to the rare good fortune of surviving the hazards of birth and infancy, the unprecedented feat of all arriving at their fifth birthday, all in good health, and all growing more alike every day! World Copyright, 1939, NEA Service, Inc.



GROWTH CURVES OF QUINTS AND "CONTROLS"

Figure 3

Growth in weight (above) and height (below) of the Quintuplets (broken lines), and of single born girls (solid lines).[32] The Quints passed the single born in weight and by rapid recent gains nearly equal the average 5-year old in height.

ings was 5.12 oz., which is 20.2 per cent of the mean weight (38.6 oz.). Converting the data to this form makes it possible to compare variability at successive ages and between different quantitative characters (weight with height, etc.), and also makes immediately available for comparison the extensive series of anthropological measurements of twins[7,12,24,29,30], triplets[14,26], and quadruplets [15,35,36], which are so valuable for the norms they tend to establish.

The large differences in weights at birth increased still further during the first eight or nine days (while weights in general were falling) and then reached an all time high peak of 23.2 per cent (Figure 5, upper curve). Thereafter the differences diminished, at first slowly (during the first three months) and then rapidly from the third to the ninth month. After weaning (10 months) a secondary slight rise occurred which continued through the second year; since then the pair difference dropped off to a level around five per cent, recently even lower. The maximal differences in weight have likewise fallen from 45.1 per cent at 10 days to 18 at one year, 11.7 at two years, 11.2 at four years, and 7.2 per cent at five years. In a broad way variability within the set decreased with rate of growth, but it is noticeable that the differences were greater at times when growth was somewhat retarded, for the Quints became temporarily more unlike in weight at certain critical periods in their history — just after birth, after weaning, and again before their tonsils were removed. Under more favorable conditions the weight differences diminished; by this criterion, present conditions since the removal of tonsils and adenoids last November, would appear to be especially favorable, for in recent months the weight gains have been rapid and the weight differences have fallen to the smallest yet reached.

The differences in heights (lower curve in Figure 5) similarly fell off sharply from 4.5 per cent when the first measurements were taken at seven months to 1.1 per cent at one year. For the first to the fifth years only minor fluctuations appear. Stature is evidently more hereditary than weight, in that it responds less sensitively to environmental influences.

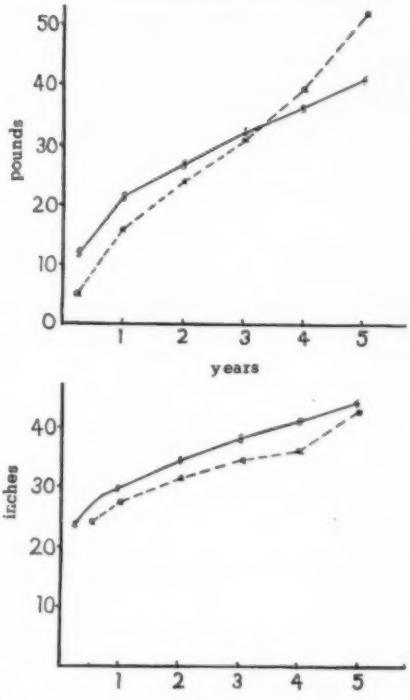
This tendency toward equalization of weights and heights was brought about especially during the first year by the faster growth of the smaller members of the set (Marie and Emilie) as compared with the larger ones (Annette and Yvonne). This point is well shown by the data in Table I. There is a strong negative correlation ($r = -0.997 \pm .003$) between each individual's size at birth and her relative growth rate (formula given in Walton and Hammond[38]). Since Marie's haemangioma

EMILIE ANNETTE YVONNE CECILE MARIE

THEIR FIFTH BIRTHDAY

Figure 2

The world has watched the amazing development of the Dionne Quintuplets, who have added to the rare good fortune of surviving the hazards of birth and infancy, the unprecedented feat of all arriving at their fifth birthday, all in good health, and all growing more alike every day! World Copyright, 1939, NEA Service, Inc.



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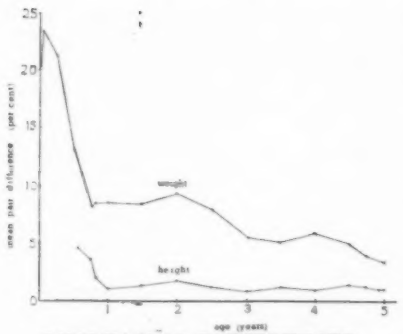
EMILIE CECILE MARIE ANNETTE YVONNE

FOUR YEARS OLD

Figure 4

In the past year there has been a considerable evening-up in the stature of the Quints. Marie is still the smallest, but today she is more like her sisters in height and weight than ever before. The chart behind Marie and Cecile shows their average height at two years (31½"), three years (34¼") and four years (38"). On their fifth birthday they averaged 42.35". They now exceed the average weight and height of single-born children.—World Copyright, 1938, NEA Service, Inc.



DECREASING DIFFERENCES

Figure 5

The average pair differences among the Quintuplets in weight (upper curve) and in height (lower curve) have decreased with age. Their weights are more variable than their heights. For corresponding twin differences see data in Tables II and III.

was cured[4,5] all have had similar illnesses and received the same care.

It is important to note that the growth rates of members of such a clone are neither equal, nor proportional to birth weight (initial capital), but are essentially regulative as is the case with egg fragments or regenerating parts, which tend to attain the potential size set by their genetic limitation.

The present differences in weight and height are like those of identical twin pairs

It has been repeatedly shown in the twin studies cited that dizygotic twin pairs differ on the average by approximately twice as much as do monozygotic pairs in a number of quantitative heredity characters (various physical and mental measurements, dermatoglyphics, etc.). In respect to weight and height the contrast between mono- and dizygotic pairs is usually well established before or by the third year[37].

Judged by reference to these standards the quintuplets clearly resemble identical twins (Table II). Their five-year weights (pounds) were: Marie 50, Emilie 52.5, Cecile 53.25, Annette 53.75, and Yvonne 50.75. Their weight differences thus range from 1.4 per cent (Cecile and Emilie) to 7.2 per cent (between Annette and Marie); the maximum difference is exceeded in about a quarter of identical twin pairs. The average difference in weights (3.8 per cent) is now less than that of the average in identical twin pairs (4.2 per cent)[24].

The situation is much the same with regard to stature. The quintuplets' heights (inches) at five years were: Marie 41.5, Emilie 42.5, Cecile 42.75, Annette 42.5 and Yvonne 42.5. The differences range from 0 to 3 per cent and average 1.11 per cent, which is practically the mean reported for identical twin pairs (Table II).

The Quints differed more in weight at birth than the average of identical twin pairs

Twins, as compared with single born, have proved to be usually undersized and more variable in size at birth. This is true of both types of twins; in fact identical pairs average smaller than fraternal at birth and then differ about as much if not actually more[7,24,26,27,30] in weights and lengths. The twin differences decrease quickly in the recovery period of the first year or two of infancy, and the growing alike proceeds much farther in identical pairs[36].

Table I. Showing the inverse relationship between weight at birth and rate of growth in weight during the first 50 months.

	Yvonne	Annette	Cecile	Emilie	Marie
Weight at birth (oz.)	46	44	37	35	31
Relative growth rate (per cent) per month	4.87	5.01	5.31	5.39	5.54

Table II. Mean per cent pair difference in weight and in height, for twins (monozygotic, 50 prs., and dizygotic, 52 prs) and for the Quintuplets.

	Identical		Fraternal	
	Weight	Height	Weight	Height
Twin pairs[24]	4.2 %	1.12 %	10.1 %	2.89 %
The Quintuplets	3.84 %	1.11 %		

Table III. Per cent differences in weight at birth between pairs from twin, triplet, quadruplet and quintuplet sets.

	Authority	Identical pairs	Fraternal pairs
Twins	Dahlberg	16.4	13.7
	v. Verschuer	15.6	13.6
	Essen-Möller	14.2	15.1
Triplets	Sasse		
	Lund	20.7	
Quadruplets	Clarke	24.1	
	Spier	23.0	
	Pryor		18.9
			16.3
Quintuplets	Hirsh		13.8
	Sato		17.6
	Elk		13.4
	Veerana		8.4
	De Blecourt	26.8	16.4
	Dafoe	20.2	
	Hamblen	20.1	

Intrauterine disturbances evidently play a still greater rôle in monozygotic triplets, quadruplets and quintuplets, for in them the same tendencies are more exaggerated (Table III). If the available cases furnish a representative sample, it appears that variability in weight at birth increases with the number of members in the identical set, from twins to quadruplets and quintuplets. No such increased variability is noted, however, when the members are fraternal.

Identical twin pairs which are especially unlike in size at birth tend to remain more than usually different. The one of the pair which was extremely retarded lags behind its mate, though by lessening amounts, even in later years and often at maturity[30,37]. In this connection it is to be noted that at 39 months "The Five" held the same order of relative weights as at birth ($r = 0.93 \pm .06$). Since then, however, the correlation has fallen ($r = 0.19 \pm .43$ between weights at birth and at 58 months), the rankings of the first four have changed very materially and only Marie is distinguished as being always the smallest. But she is now only about two pounds and .75 inch below their common average. Among the Morlock identical quadruplets *D* and *B* who were smallest at birth still held their original positions at eight years of age[15,36].

A general view of the changes

The most logical general explanation of the trends described is that the prenatal environments obtaining in twin and multiple birth pregnancies are not only in general retarding but are also markedly unequal (with respect to size and position of the embryos when first formed, to placental circulation, etc.), so that birth weights vary by relatively large amounts, particularly in quintuplet sets of monozygotic origin (if the few known cases can be regarded as typical). (Height is distinctly less altered by these disturbing conditions than is weight.) Birth, however, brings release from the repressive and unequal intrauterine conditions, and some recovery soon occurs when the fully separated and independent individuals encounter the more congenial and more similar external postnatal environment usually provided. Environmental inequalities having decreased, hereditary constitutional growth factors are more free to express themselves, and they gradually acquire a predominant controlling influence on growth. Accordingly, in this period of early infancy, genetically identical pairs or sets tend to become much more nearly alike in weight and in height than do fraternal pairs. But even the identical pairs or sets often appear unable to outgrow altogether the large differences with which they entered the world.

It would seem likely that such marked and somewhat persistent physical differences in weight and height, traceable to prenatal inequalities, might continue to exert a perceptible influence in after years, affecting perhaps not only other physical characters but also the mental, and especially the social development and rankings of the individual members of the set[17,32]. It may well be that nongenetic differences in maturity at birth (involving advantages or handicaps in size, strength, agility and dexterity, activity and endurance) may initiate and tend to stabilize personality differences in leadership, originality, aggressiveness, attitude toward authority and social interests.

The larger problem remains unsolved as to whether the psychological differences reported among the quintuplets[17,32] were ever more marked, or are destined to be more fixed and permanent, than their physical size differences.

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HEREDITY IN INFECTIOUS DISEASE

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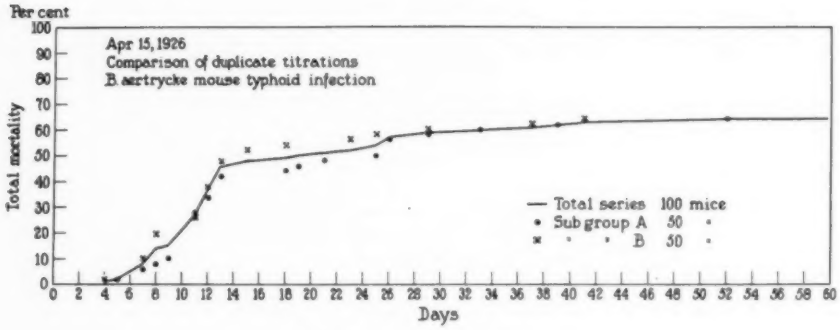
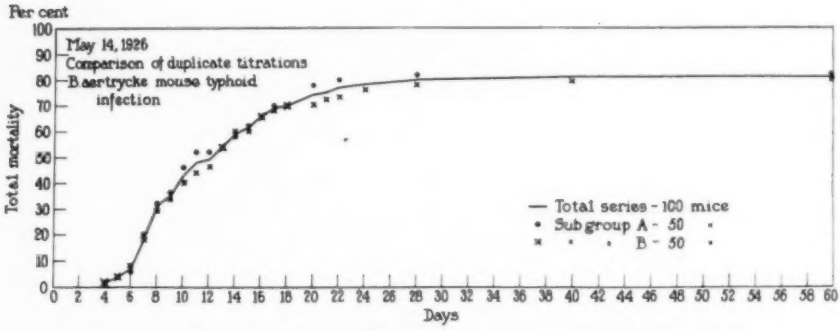
HEREDITY in infectious disease, always a subject for speculation, has but recently come under the scrutiny of the experimentalist. In 1905, Biffen crossed strains of wheat resistant to yellow rust with strains susceptible to this pathogen, and tested the progeny under field conditions. Inheritance of resistance appeared to follow a single factor pattern with susceptibility dominant. Moreover, he found that modifications in nutrition increased the susceptibility of genetically resistant individuals. Many plant infections have since been studied with techniques aiming at once at naturalness of mode of infection together with adequate control. Resistance has been found to be inherited in some instances on a multiple and in others on a single factor basis, resistance being dominant more frequently than susceptibility. Inborn resistance to one infection generally proved to be independent of resistance to another. No anatomical or physical mechanism has thus far been proven causally related to resistance or susceptibility.

Investigators of infectious diseases of animals have paid little attention until recently to the possible regulation of resistance by inborn factors and to the differentiation of individuals according to these factors. Common practice shows that if a batch of animals is given an injection of a virulent agent by some artificial route, the great majority succumb within a few hours. Moreover, if less virulent agents, smaller doses, or more natural routes of infection are used, a percentage of a batch of individuals may survive, but if the test is run in duplicate or repeated, the percentage of survivors varies in a random manner. Such differences in survival rate and in fate of individuals have heretofore been attributed solely to uncontrolled errors of technique.

Our investigations of inborn resistance commenced in 1923, when it was found that batches of laboratory bred mice, exposed to infectious agents in a way simulating nature, differed from batches of uncontrolled mice in responding as a group in a relatively predictable manner.[1] (See Figures 6 and 7.) Moreover, the survival of some individuals as contrasted with the death of others under apparently similar and controlled conditions took on a possible significance. Although the reaction of a given individual of the group could not be predicted, differences in individual response were regarded as due possibly not to technical irregularities but to differences in the degree of inborn resistance.

This idea was borne out by the results of progeny tests.[2,3] Five hundred females of a hybrid stock of mice fed on the Steenbock diet, of which approximately 37.4 per cent succumb following a standard dose of mouse typhoid bacilli given by mouth (See Figure 8) were mated at random with 100 males. When the resulting litters were weaned, the parents were tested with the routine dose of mouse typhoid by mouth. From parents dying within ten days following infection, progeny were saved and mated brother to sister, as were progeny from parents surviving. These progeny were then bred and subsequent litters tested with mouse typhoid. The results showed that progeny from parents dying early after a test infection were more susceptible than those from parents surviving (Tables I and II). This finding is regarded as proof that parents dying early were actually more susceptible by inheritance than those surviving, or in other words, that the differences in the response of individuals to a natural type of infection under conditions in which other variables are con-

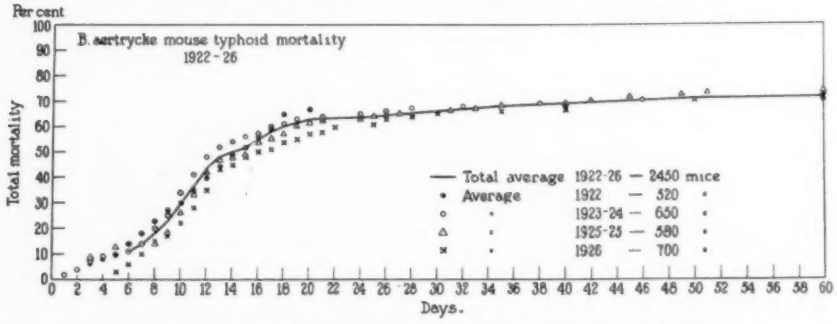




DEATH RATES IN EXPERIMENTAL MOUSE-TYPHOID INFECTION

Figure 6

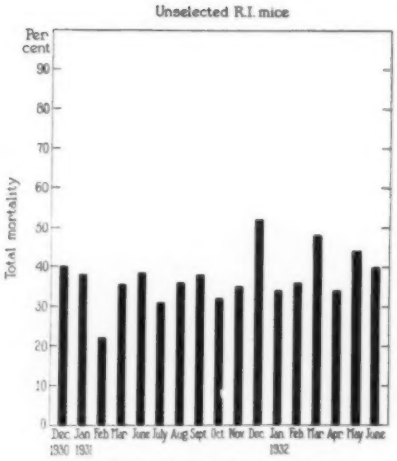
Comparison of duplicate and repeated tests of mortality of R. I. stock mice on bread and milk diet, following stomach tube inoculation of 5,000,000 *B. aertrycke* mouse typhoid bacilli. Note the five-day incubation period, the approximately 70 per cent mortality at 30 days and 30 per cent survival on duplicate and repeated tests (*Medicine* 11:321, 1932).



TWENTY-FIVE HUNDRED MICE DIE—OR RESIST TYPHOID

Figure 7

Comparison of average mortalities of R. I. stock mice on bread and milk diet, following stomach tube inoculation of 5,000,000 *B. aertrycke* mouse typhoid bacilli. A series of tests on 2,450 mice covering a period of five years. Note the close similarity of results, indicating control of variables (*Medicine*, 11:321, 1932).



MONTHLY DEATH RATES

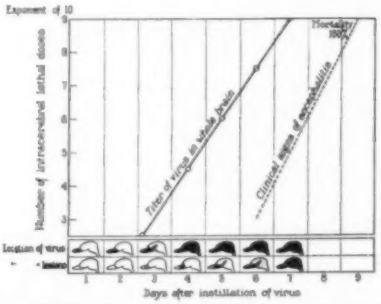
Figure 8

Mortalities of unselected R. I. stock mice on modified Steenbock diet tested monthly with 5,000,000 *B. enteritidis* mouse typhoid bacilli given by stomach tube. Note close approximation of mortality percentages at 37.4 ± 1.6 per cent (*J. Exp. Med.* 57:793, 1933).

trolled are due to differences in their innate resistance.

From the highly susceptible parents, lines of varying high susceptibility to mouse typhoid and to encephalitis virus were developed through selection and brother-to-sister inbreeding. Susceptibility remained unchanged for twelve generations in lines in which it was greatest at the outset, while in lines in which it was intermediate, susceptibility increased through selection. The same circumstances proved to be true for the resistant lines. The difference in susceptibility of the least susceptible and least resistant lines is of the order of 1,000 lethal doses or of mortalities to a standard dose of 95 per cent as contrasted with 10 per cent (see Table III).

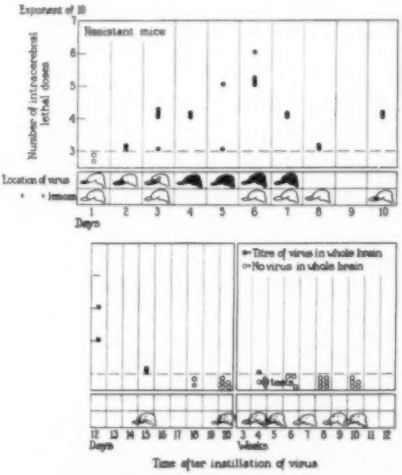
Crossing highly susceptible with highly resistant lines and testing F_1, F_2, and backcross progeny resulted in percentage mortalities in the neighborhood of those expected on the basis of a single factor type of Mendelian inheritance for resistance to mouse typhoid and to en-


Exponent of 10
Number of intracerebral lethal doses
Titer of virus in whole brain
Clinical signs of encephalitis
Location of virus
Days after instillation of virus

TIME TABLE OF VIRUS INFILTRATION IN SUSCEPTIBLE MICE

Figure 9

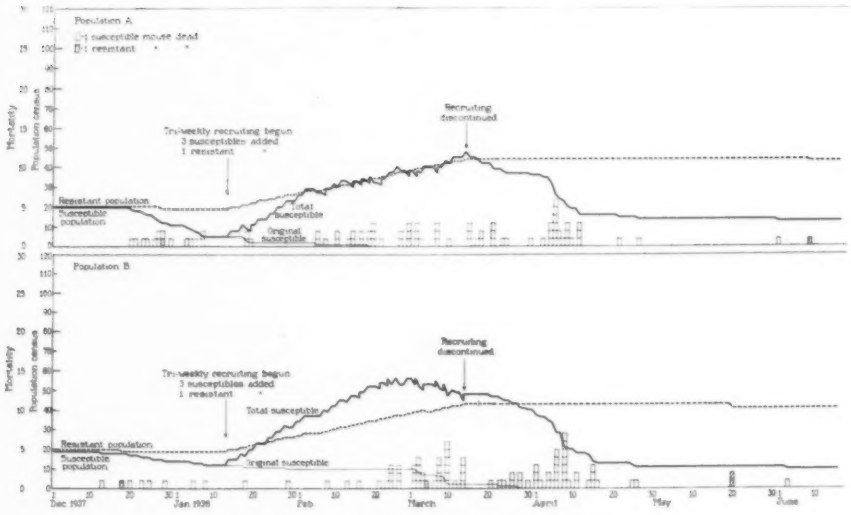
Time relation between the onset of encephalitis in innately susceptible mice instilled with St. Louis encephalitis virus and the appearance of tissue alterations and virus in the brain. Note that virus reaches the brain in 24 hours and multiplies rapidly there; that lesions appear on the third day, spread rapidly, and destroy the brain; and that symptoms commence on the sixth day and prove fatal to 100 per cent of the tested mice (*J. Exp. Med.* 63: 433, 1936).



IN RESISTANT MICE

Figure 10

Distribution of virus and lesions in resistant mice following nasal instillation of St. Louis encephalitis virus. Note that virus reaches the brain in 24 hours, does not multiply greatly, but persists 30 days; that lesions appear on the 10th day, remain focal in nature, and persist 12 weeks; and that the mice remain well (*J. Exp. Med.* 63:827, 1936).



EPIDEMICS IN MIXED POPULATIONS

Figure 11

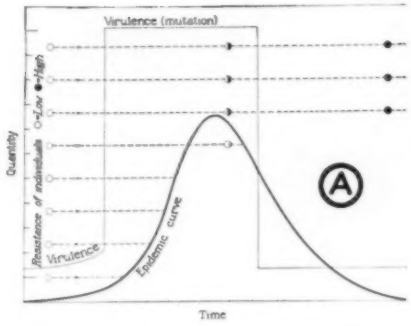
Spread of mouse typhoid among populations of innately susceptible and resistant mice. Populations composed of twenty susceptibles plus twenty resistants were assembled in single large pens. Ten typhoid carriers were introduced and the infection allowed to spread naturally. Later recruits were added, three susceptibles to one resistant. Note that all, or nearly all the innately susceptible individuals succumb, whereas the innately resistant remain well.

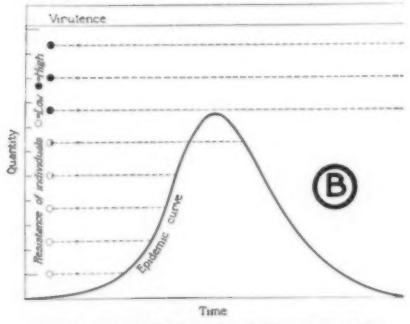
cephalitis virus as well. Resistance proved dominant in each instance. Further tests showed that the amount of inherent resistance displayed by an individual to one infectious agent cannot be taken without experiment as a measure of its resistance to another. In concluding this brief summary, we wish to point out the close parallelism between our findings on animal infections and those of workers on plant infections.

The thesis of variability of host resistance and its regulation by inborn factors has both particular and general bearing upon experimentation in infectious disease. The particular effect of innate factors on type of clinical disease and tissue changes is exemplified in studies on susceptible and resistant mice following nasal administration of St. Louis encephalitis virus[4,5]. Virus dropped into the nares of batches of susceptible and resistant mice can be recovered from the olfactory bulbs of both susceptibles and resistants 24 hours later. But in the susceptible mice the virus multiplies rapidly, with lesions on the third day, signs of disease on the sixth day, and destroys most of the brain and kills the animal by the ninth day. In the resistant mice, on the other hand, it does not multiply greatly, but persists as long as 30 days. Lesions do not appear before the tenth day and then they are focal in nature and may persist for four months. Of most importance is the fact that the resistant mouse remains well (see Figures 9 and 10).

Genetic Factors and Epidemics

The rôle of inborn resistance factors in epidemology is now being investigated by experimental studies on mouse typhoid. Under conditions in which the disease is allowed to spread naturally among herds of mice comprised of different proportions of individuals of innately high or low susceptibility, 85 to 95 per cent of the innately susceptible succumb to the infection, in contrast to less than five per cent of the innately re-





TWO THEORIES OF EPIDEMICS

Figure 12

A—Figure showing virulence increasing and causing the epidemic. Population constituents are alike at the outset but some become immunized through exposure to small doses and hence survive. *B*—Figure showing virulence stable throughout but population constituents differing at the outset in resistance. Survivors in this case are the individuals which were originally resistant (*Scientific Monthly* 48:69, 1939).

sistant, regardless of whether either group constitutes a large or small per cent of the population, respectively. The surviving population is therefore comprised largely of individuals known at the outset to be innately resistant. These resistants are, nevertheless, apt to have become infected and to harbor mouse typhoid bacilli. (See Figure 11.)

Under conditions in which recruits are added to surviving populations comprised chiefly of innately resistant individuals mouse typhoid spreads to both innately resistant and susceptible. Mortality from the infection, however, is limited again almost exclusively to the innately susceptible recruits and is "sporadic" or "epidemic" in character according to the numbers and proportions added. Innately resistant recruits remain well unless subjected to some nonspecific hazard, such as heat or overcrowding, in which case both they and the susceptibles succumb in proportions similar to their relative numbers in the population. In all instances survivors are almost exclusively the individuals known at the outset to have been innately

TABLE I. Results of tests on progeny of parents dying within ten days following test infection with mouse typhoid. Note relatively high mortalities of selected progeny, 60.9 per cent of 1,429 progeny dying as compared with 34.7 per cent of unselected controls (*J. Exp. Med.* 57:793, 1933).

A) Progeny of Selected Parents Dying 1-10 Days after Injection							B) Progeny of Selected Parents Dying 11-20 Days after Injection					
Litter Identification	Sire Identification	No. Dams	Progeny Tested: No. Litters	No. Progeny	No. Dead	% Dead	Litter Identification	Sire Identification	No. Dams	Progeny Tested: No. Litters	No. Progeny	No. Dead	% Dead
1	185.0	7	24	135	110	81.5	2	207.3	4	6	40	32	80.0
A	188.0	6	11	52	46	88.4	6	207.3	2	5	26	20	77.0
7	159	6	11	59	42	71.2	9	207.3	4	10	66	28	42.5
1	137	6	20	105	74	70.4							
9	8.0	4	17	64	47	73.5							
C	277	6	8	43	31	72.0							
3	206.6	7	14	57	40	70.3							
E	484	6	13	57	40	70.3							
F	86.0	4	6	30	26	86.6							
5	330.1	6	13	78	47	60.3							
2	140	7	22	109	72	67.0							
1	81.0	7	17	87	69	79.4							
4	176	9	29	120	96	80.7							
3	206.0	3	16	128	61	50							
J	330.3	8	16	98	69	69.0							
H	178	5	12	68	32	47							
1	38	6	16	77	27	35	7						
8	256.0	5	7	41	13	31.7							
Total	18	109	280	1429	870	60.9							

TABLE II. Results of tests on progeny from parents surviving test infection with mouse typhoid. Note relatively low mortality of 139 progeny, 20.1 per cent, never exposed to mouse typhoid (*J. Exp. Med.* 57: 793, 1933).

Litter Identification	Sire Identification	No. Sires	No. Dams	Progeny Tested: No. Litters	No. Progeny	No. Dead	% Dead	Remarks
1	97	1	8	10	75	12	16.0	First Selection
2	71	1	13	7	34	11	32	5,000,000 organisms
3	0	1	4	4	20	3	15.0	per ccmm
Totals		3	26	21	129	26	20.1	
1		10	42	26	460	42	9.1	Second Selection
2		4	14	10	80	16	20.0	5,500,000 organisms
3		1	3	1	6	4	66.6	per ccmm
Totals		15	59	105	546	62	11.3	
1		32	126	142	833	130	15.6	Third Selection
2		4	15	19	110	13	10.1	50,000,000 organisms
Totals		36	147	161	943	142	14.8	
1		73	46	90	511	91	17.8	Fourth Selection
2		4	19	20	84	13	15.5	90,000,000 organisms
Totals		77	105	110	595	104	17.5	

resistant. Finally, there was no tendency for known susceptibles to become immunized through herd exposure during an epidemic or after an epidemic has passed.

Given the fact that inherited factors are of basic importance in determining the character of infection in both the individual and the herd, our present interests are devoted to ways of modifying the expression of these factors through environmental ones. Chief of those tested thus far has been diet. Diet in animals as in plant infections proves capable of changing susceptibles to resistants and vice versa. Epidemics may be started and terminated by merely altering the dietary factor, even though it be maintained always above the threshold of actual deficiency.

A Theory of Epidemics

These experimental findings on host factors, together with others referable to the infecting agent, have modified the current theory of epidemics as follows. (See alternative theories outlined in Figure 12.) We now believe epidemics are caused in hitherto uninfected populations by the introduction and spread of a highly virulant yet stable infecting agent. In populations already infected the agent remains stable and the epidemic is caused by a lowering of population resistance through the addition of susceptible immigrants or through some generally depleting factor, such as inadequate diet. This lowered susceptibility is followed by multiplication of the causative agent in already infected hosts and consequently an increase in dosage of the agent to which the community at large is exposed. This increase in dosage is the immediate cause of the epidemic whether the agent be introduced from without or be already present within the population. In either case the individual constituents of a population or of immigrants into it are not at all relatively alike with regard to susceptibility, but differ widely. Those who first contract severe illness or succumb to it do so because at the outset they were most susceptible. Those who escape entirely or with minor illnesses do so because at the outset they were more resistant. The epidemic curve describes differences in resistance of individuals and the average resistance level of the population to the disease-producing agent.

TABLE III. Mortalities in three tests on inbred selected lines, following injection of *B. enteritidis* mouse typhoid *per os* or St. Louis encephalitis virus intranasally. Note high mortalities to bacteria (98.4 per cent) and virus (96.8 per cent) in the bacteria-susceptible-virus-susceptible line, the high mortality to bacteria (96 per cent) and low mortality to virus (14.8 per cent) in the bacteria-susceptible-virus-resistant line, and the low mortality to bacteria (18.3 per cent) and high mortality to virus (94.7 per cent) in the bacteria-resistant-virus-susceptible line.

Date	Bacteria-susceptible-virus-susceptible line (BSVS)						Bacteria-susceptible-virus-resistant line (BSVR)						Bacteria-resistant-virus-susceptible line (BRVS)					
	Tests with *B. enteritidis*			Tests with virus			Tests with *B. enteritidis*			Tests with virus			Tests with *B. enteritidis*			Tests with virus		
	No. injected	No. dead	Per cent dead	No. injected	No. dead	Per cent dead	No. injected	No. dead	Per cent dead	No. injected	No. dead	Per cent dead	No. injected	No. dead	Per cent dead	No. injected	No. dead	Per cent dead
1934																		
Nov. 2	19	19	100	10	10	100	19	19	100	18	1	5.5	7	0	0.0	5	5	100
1935																		
Jan. 29	69	68	98	69	63	91.3	36	17	94	36	0	0	36	0	0	36	0	0
Oct. 1	67	66	97.9	33	30	90	63	41	93.2	66	0	0	36	13	32.4	67	63	97
Nov. 25	12	12	100	15	15	100	17	17	100	22	1	4.5	11	2	18.2	10	9	90
Totals	167	165	98.4	125	121	96.8	134	119	94.0	122	18	14.8	126	23	18.3	118	112	94.7

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MEN AND MICE AT EDINBURGH

Reports from the Genetics Congress

THE Seventh International Congress is now history. The crisis, which had threatened all summer, broke just as the Congress convened, though war was not actually declared until after the Congress adjourned. Contions for holding an International Congress could hardly have been worse, but nearly two hundred Americans went in spite of the uncertainty. The final program of the Congress, issued just before it convened, closed with the following statement: "To construct a program of this kind is always difficult: in these days it is almost impossible. Those who recognize its faults, and they are many, will surely excuse them when they learn that after this program had been printed, and only ten days before the actual opening of the Congress, no fewer than fifty names and titles had to be removed and the whole program hurriedly recast."

When this final program went to press, the Russian delegation had been withdrawn. On the second or third day of the Congress at Edinburgh (August 22-30) the German, Hungarian, Scandinavian, and Swiss delegations had left. Those who still remained were mainly the British and the Americans. Since Dr. Vavilov was not present, the Congress elected Dr. Crew as its President.

On account of the interruption of Atlantic travel, very few of the Americans have returned. So that details regarding the Congress will have to wait until the next issue of the JOURNAL.

Two significant items have been received at this time,—one of these deal with mice and the other with men. To avoid copyright complications, or a charge of plagerism, it seems best to reverse Steinbeck's order of listing these mammals in the title of this notice. Also the approach to the problems of mammals in general and of our own species in particular is different enough from that of Steinbeck to emphasize the contrast by the inversion.

The matter of men insofar as the Genetics Congress dealt with it, and in the light of our present information, is contained in an unofficial statement (published in full below) termed by some signers, "The Geneticists' Manifesto." It was prepared in response to a question cabled by Watson Davis, editor of *Science Service*, to a number of geneticists in Great Britain, asking "How could world's population improve most effectively genetically?" The statement below was prepared jointly by a group of those to whom it was addressed; it was signed originally by Crew, Haldane, Harland, Hogben, Huxley, Needham and Muller. Dr. Muller writes about this statement, "No attempt was made to secure as many signatures as possible or to bring up the matter for public discussion, but with very few exceptions all those asked to sign it did so. No claim is here put forward that these signatures are or are not 'representative' (as Mr. Watson Davis has requested), it being thought fit for the signatures to speak for themselves concerning this matter." This statement is carefully and thoughtfully drawn, and sound enough to serve as a basic platform of departure for discussing the genetic implications of human improvement. It read as follows:

The "Manifesto"

The question "how could the world's population be improved most effectively genetically" raises far broader problems than the purely biological ones, problems which the biologist unavoidably encounters as soon as he tries to get the principles of his own special field put into practice. For the effective genetic improvement of mankind is dependent upon major changes in social conditions, and correlative changes in human attitudes. In the first place there can be no valid basis for estimating and comparing the intrinsic worth of different individuals without economic and social conditions which provid[e] approximately equal opportunities for

all members of society instead of stratifying them from birth into classes with widely different privileges.

The second major hindrance to genetic improvement lies in the economic and political conditions which foster antagonism between different peoples, nations and "races". The removal of race prejudices and of the unscientific doctrine that good or bad genes are the monopoly of particular peoples or of persons with features of a given kind will not be possible, however, before the conditions which make for war and economic exploitation have been eliminated. This requires some effective sort of federation of the whole world, based on the common interests of all its peoples.

Thirdly, it cannot be expected that the raising of children will be influenced actively by considerations of the worth of future generations unless parents in general have a very considerable economic security and unless they are extended such adequate economic, medical, educational and other aids in the bearing and rearing of each additional child that the having of more children does not overburden either of them. As the woman is more especially affected by child bearing and rearing she must be given special protection to ensure that her reproductive duties do not interfere too greatly with her opportunities to participate in the life and work of the community at large. These objects cannot be achieved unless there is an organization of production primarily for the benefit of consumer and worker, unless the conditions of employment are adapted to the needs of parents and especially of mothers, and unless dwellings, towns and community services generally are reshaped with the good of children as one of their main objectives.

A fourth prerequisite for effective genetic improvement is the legalization, the universal dissemination, and the further development through scientific investigation, of ever more efficacious means of birth control, both negative and positive, that can be put into effect at all stages of the reproductive process — as by voluntary temporary or permanent sterilization, contraception, abortion (as a third line of defense), control of fertility and of the sexual cycle, artificial insemination, etc. Along with all this the development of social consciousness and responsibility in regard to the production of children is required, and this cannot be expected to be operative unless the above mentioned economic and social conditions for its fulfilment are present and unless the superstitious attitude towards sex and reproduction now prevalent has been replaced by a scientific and social attitude. This will result in its being regarded as an honour and a privilege, if not a duty, for a mother, married or unmarried, or for a couple, to have the best children possible, both in respect of their upbringing and of their genetic endowment, even where the latter would mean an artificial — though always voluntary — control over the processes of parentage.

Before people in general, or the state which is supposed to represent them, can be relied upon to adopt rational policies for the guidance of their reproduction, there will have to be, fifthly, a far wider spread of knowledge of biological principles and of recognition of the truth that both environment and heredity constitute dominating and inescapable complementary factors in human well-being, but factors both of which are under the potential control of man and admit of unlimited but interdependent progress. Betterment of environmental conditions enhances the opportunities for genetic betterment in the ways above indicated. But it must also be understood that the effect of the bettered environment is not a direct one on the germ cells and that the Lamarckian doctrine is fallacious, according to which the children of parents who have had better opportunities for physical and mental development inherit these improvements, biologically, and according to which, in consequence, the dominant classes and peoples would have become genetically superior to the underprivileged ones. The intrinsic (genetic) characteristics of any generation can be better than those of the preceding generation only as a result of some kind of *selection*, i.e., by those persons of the preceding generation who had a better genetic equipment having produced more offspring, on the whole, than the rest, either through conscious choice, or as an automatic result of the way in which they lived. Under modern civilized conditions such selection is far less likely to be automatic than under primitive conditions, hence some kind of conscious guidance of selection is called

for. To make this possible, however, the population must first appreciate the force of the above principles, and the social value which a wisely guided selection would have.

Sixthly, conscious selection requires, in addition, an agreed direction or directions for selection to take, and these directions cannot be social ones, that is, for the good of mankind at large, unless social motives predominate in society. This in turn implies its socialized organization. The most important genetic objectives, from a social point of view, are the improvement of those genetic characteristics which make (a) for health, (b) for the complex called intelligence and (c) for those temperamental qualities which favour fellow-feeling and social behaviour rather than those (today most esteemed by many) which make for personal "success," as success is usually understood at present.

A more widespread understanding of biological principles will bring with it the realization that much more than the prevention of genetic deterioration is to be sought for and that the raising of the level of the average of the population nearly to that of the highest now existing in isolated individuals, in regard to physical well-being, intelligence and temperamental qualities, is an achievement that would — so far as purely genetic considerations are concerned — be physically possible within a comparatively small number of generations. Thus everyone might look upon "genius", combined of course with stability, as his birthright. And, as the course of evolution shows, this would represent no final stage at all, but only an earnest of still further progress in the future.

The effectiveness of such progress, however, would demand increasingly extensive and intensive research in human genetics and in the numerous fields of investigation correlated therewith. This would involve the cooperation of specialists in various branches of medicine, psychology, chemistry and, not least, the social sciences, with the improvement of the inner constitution of man himself as their central theme. The organization of the human body is marvellously intricate and the study of its genetics is beset with special difficulties which require the prosecution of research in this field to be on a much vaster scale, as well as more exact and analytical, than hitherto contemplated. This can, however, come about when men's minds are turned from war and hate and the struggle for the elementary means of subsistence to larger aims, pursued in common.

The day when economic reconstruction will reach the stage where such human forces will be released is not yet, but it is the task of this generation to prepare for it, and all steps along the way will represent a gain, not only for the possibilities of the ultimate genetic improvement of man, to a degree seldom dreamed of hitherto, but at the same time, more directly, for human mastery over those more immediate evils which are so threatening our modern civilization.

(original signers)

F. A. E. Crew, F.R.S. — J. S. Huxley, F.R.S.
J. B. S. Haldane, F.R.S. — H. J. Muller
S. C. Harland — J. Needham
L. T. Hogben, F.R.S.

(additional signers)

G. P. Child — C. L. Huskins
P. R. David — W. Landauer
G. Dahlberg — H. H. Plough
Th. Dobzhansky — E. Price
R. A. Emerson — J. Schultz
C. Gordon — A. G. Steinberg
John Hammond — C. H. Waddington

Action regarding mice was taken by a committee appointed to deal with the nomenclature of genes in mice, the reporting of genetic progress in mouse genetics, and the preservation in a safe place of genes of value to mice geneticists. This committee adopted the following report which has been transmitted by Dr. Hans Grueneberg, 131 Park Side Way, North Harrow, Middlesex, England, the Secretary of this committee. The text of this report follows:

A CIRCULAR letter signed by L. C. Dunn, W. H. Gates, G. D. Snell, and W. L. Russell was recently forwarded to biologists interested in mouse genetics, asking for opinions with regard to the possible establishment of a Committee on Mouse Genetics Nomenclature and of a Mouse Genetics News Service. Nearly 100 replies were received, all favourable. Professors F. A. E. Crew and L. C. Dunn and Dr. G. D. Snell were appointed as the Committee on Mouse Genetics Nomenclature.

The present meeting was called to consid-

er a set of nomenclature rules drawn up by the above Committee, and to discuss details of the News Service. Unfortunately none of the Committee was able to be present.

Dr. A. L. Hagedoorn (Holland) was in the chair. Those present included:

H. B. Andervont	U. S. A.
Ch. Auerbach	Edinburgh.
R. C. Bamber	Liverpool.
G. M. Bonser	Leeds.
B. M. Braithwaite	Liverpool.
F. G. Carnochan	U. S. A.
P. R. David	U. S. A.
W. H. Gates	U. S. A.
L. C. Glass	U. S. A.
P. A. Gorer	London.
H. Grueneberg	London.
A. Haddon	London.
J. B. S. Haldane	London.
J. M. Henderson	Montreal.
W. K. Hirschfeld	Holland.
H. L. Ibsen	U. S. A.
I. Chester Jones	Liverpool.
N. Kobozieff	France.
S. B. North	London.
J. H. Pickard	Edinburgh.
S. C. Reed	Montreal.
W. L. Russell	U. S. A.
F. W. Tinney	Rothamsted.
G. Woolley	U. S. A.

The recommendations of the meeting as regards nomenclature have been submitted to the Committee.

The Director and staff of the Roscoe B. Jackson Memorial Laboratory in Bar Harbor, Maine, U. S. A., had kindly offered facilities for the publication in mimeographed form of the Mouse Genetics News. This offer was gratefully accepted. It was suggested that a register of stocks and the various Pure Lines should be drawn up; this should end the confusion in the naming of Pure Lines used in various laboratories which has arisen during the last few years. Stock lists of all the laboratories concerned should be published from time to time. It was further suggested that notice should be given by a laboratory before any stocks are discontinued; it has happened several times in the past that valuable material has been irretrievably lost, because every laboratory has relied on other places for its maintenance. The News Service should also arrange for exchange of stocks, and it is hoped that its activities may be extended to rabbits and other rodents. An appeal should be made to all laboratories concerned to collaborate whole-heartedly by promptly answering correspondence and sending information.

The meeting then discussed the establishment of centres, preferably in the U. S. A., for the maintenance and safe keeping of stocks, particularly of genes (pathological and otherwise) which are not purposely kept by the fancy. The continuity of genetical work depends on keeping our genes alive; genes which have died out are as irrevocably lost as extinct animal or plant species. It was urged that this matter should receive the immediate consideration of the News Service, and that an appeal should be made to the Carnegie and Rockefeller Foundations for financial assistance.

H. GRUENBERG.

Let us hope that there is something prophetic in this gathering of genetic research workers from the ends of the earth just as the world plunges again into the ancient futility of "settling" its problems by force. We might envision the "manifesto" as the final protest of our new brain as the medulla oblongata and the older emotional reflexes of our race again take over control. It has taken seven years to arrange this International Congress while the world has been "at peace." What of the future now we are no longer "at peace" again? Certainly the signers of "Geneticists' Manifesto" have laid a rational foundation for considering problems of human betterment, to which "conservatives" and "radicals" will both subscribe. Perhaps the members of this committee were not born into a rational species. Their plea to put honest and realistic approaches first will also fall not so much on deaf ears, as on ears distracted by the noise of war, and on the minds blinded by that futile urgency to the fact that after this war we have the greater job of building a peace which will work—and *last*. If this fails it seems unlikely that even in the New World will the genes of mice long find a cloistered place of safety, for one Evolutionary Experiment in magnifying the fore part of the neural tube seems fated to turn out to have been only a very qualified success, and slated for the cosmic dustbin.

SOME MATERIALS FOR GENETIC INSTRUCTION*

A. C. FRASER

IN the teaching of genetics there is need for laboratory material which is not only easy to classify but is also of such a nature that it can be brought to a classifiable stage in a reasonably short time. *Drosophila melanogaster* excels in these respects and in a number of other ways as well. Its exclusive use in the laboratory, however, is likely to give students the impression that it is difficult to demonstrate genetical principles with any other species. In departments of plant breeding and of botany, particularly, the introduction of some plant material seems highly desirable. This can be done with ears of corn showing segregation in aleurone and endosperm characters, since each seed becomes a distinct unit of study and large counts are possible with relatively few ears. There is much to be said, however, in favor of giving students material which they can plant and study as it develops. Because of the time element, mature plant characters cannot be used satisfactorily unless the genetics instruction is spread over a full year. Seedling characters, however, can be used to good advantage, not only for the simpler 3:1, 1:1, 9:7, and other segregations, but also for the illustration of gene linkages.

It so happens that in the second chromosome of maize, there are four genes close enough to each other to provide three regions of definite linkage. By good fortune, all four genes give phenotypic effects classifiable in the seedling stage. These are the pairs $Lg_1 - lg_1$, $Gl_2 - gl_2$, $B - b$, and $V_4 - v_4$. In the summary[2] of linkages presented in Cornell University Memoir 180 (1935), the following relationships were set forth:

lg_1	gl_2	B	v_4
0	19	38	71

The characters represented by these symbols may be described as follows:

lg_1—liguleless leaf-1. Ligule absent in the seedling and throughout the life of the plant. The leaves show a tendency to grow upright and the plant has a characteristic appearance even in the seedling stage, hence classifications are easily made. (See Figure 14.) In any doubtful cases, a quick examination of the first seedling leaf shows whether or not the ligule is present. Viability is normal.

gl_2—glossy-2. Seedling leaves glossy. Classification easy in the early stages, but usually impossible in the mature plant. Dr. A. M. Brunson[2] some years ago made the discovery that if corn seedlings are sprinkled with water from a fine-spray watering pot, the moisture quickly runs off the normal (*Gl_2*) plants, but collects in small drops on the glossy surfaces. (Figure 13.) This greatly facilitates classification. The viability of the seedlings is good.

B—Plant color intensifier. Its classification in mature plants is usually made without difficulty. In the seedlings, however, the distinction between *B* and *b* can only be made in the presence of the super-g allele of the *R-r* pair for aleurone color. The mode of interaction of these genes will be apparent in the following table. (See Emerson[1].)

	PLANT COLOR WITH	
	R^r or r^r	R^g or r^g
A_1 B Pl	Purple	Purple
A_1 B pl	Sun red	Sun red
A_1 b Pl	Dilute purple	Green
A_1 b pl	Dilute sun red	Green

An essential point to remember, for those who wish to maintain such material for class use, is that it should be kept homozygous for R^g or r^g, never with R^r or r^r. In the presence of R^g or r^g (green-anthered plants), the difference between the *B* and *b* seedlings is that between reddish stems and green.

All stocks must be kept homozygous for A_1.† The *Pl-pl* constitution of the seedlings is probably not of great importance provided one or the other allele is kept homozygous. The segregation of

*Paper No. 222, Department of Plant Breeding, Cornell University, Ithaca, New York.

†In most stocks of corn, the A_2 and A_3 genes are present in the homozygous dominant condition and these can be disregarded. A_1 is also found in all but special genetical stocks.

SEGREGATION OF VIRESCENTS AND GLOSSIES
Figure 13

Back cross progeny of $\frac{Lg_1\ Gl_2\ B\ V_4}{lg_1\ gl_2\ b\ v_4} \times lg_1\ gl_2\ b\ v_4$, showing virescents and glossies among the normals. The seedlings have been sprayed with water and this shows in droplets on the glossy plants. These plants are also segregating for stem color and for normal *vs* absent ligule.

the *Pl-pl* pair might render the *B-b* distinction more difficult.

v_4—Virescent-4. Seedlings yellowish green, turning green slowly. This type remains yellowish for a longer time than most of the other virescents. The classifications are good and the viability, normal. (See Figure 13.)

For one who has the facilities for growing corn, it will not be difficult to make up various linkage combinations in the heterozygous condition and back-cross these to the multiple recessive type. The resulting ears can then be turned over to a class for shelling and planting. Extensive counts can be obtained in the seedling stage within three weeks, in a relatively small area of greenhouse bench.

The maintenance of the material presents no great difficulties, since the multiple recessive stock is sufficiently vigorous to be propagated for several years by selfing or sib-crossing. If the seeds from back-crossed ears are planted thickly and culled in the seedling stage to leave the $Lg_1\ Gl_2\ B\ V_4$ type, one can use such plants as F_1's, since they will be heterozygous for the quadruple recessive. Pure recessives can be obtained in a similar manner, or a stock of $lg_1\ gl_2\ b\ v_4$ can be maintained by selfing or sib crossing. About every two or three years, it will probably be necessary to outcross homozygous stocks, to offset the harmful ef-

DIFFERENCES CONDITIONED BY *Lg* GENE

Figure 14

To show the difference between *Lg* (left) and *lg* seedlings at about 18 days of age. Both plants are *B gl* V_4. (Photos by W. R. Fisher).

fects of continuous self-pollination. Precautions mentioned above, with respect to *A*, *B*, and R^g r^g, should be kept in mind when this is done.

The virescent seedlings usually develop and hold their yellowish green color best under conditions of lower temperatures and weaker light than are usually made available to growing corn. The expression of *B*, on the other hand, is best in a strong light. Fortunately, v_4 will stay yellowish in a moderately strong light, provided the temperature can be kept down. Good results have been obtained at Ithaca by planting the seeds in sand and keeping the air temperature warm (70°-75° F.) for the first week, to insure good germination, changing to 60°-65° F. for the subsequent development of the seedlings. Occasionally the virescent plants will start to develop chlorophyll before the *B* character (red stem) is best classified. In such cases tooth picks can be used to mark the v_4 seedlings, and the planting left until the reddish color develops strongly in the stems. Thus one can be sure of the v_4 plants even after they are indistinguishable from their normal sibs, and *B* can be given every opportunity to develop clearly. In periods of weak light, the taking on of reddish color by *B*-type plants can often be hastened by root pruning the seedlings. A knife, run between the rows, will accomplish this nicely. It has also been observed that red color will come out more strongly in seedlings grown in sand or soil which is low in nitrogen.

With these seedling types, it is possible, within a few weeks, to study single, double, and triple crossing over, interference and coincidence, and certain other aspects of the phenomenon of linkage.

Four successive plantings can easily be made in the course of a 15-week semester to meet the needs of a large class or to provide larger numbers for a small group.

Corn material of this kind has been tested rather extensively by genetics classes at Cornell and at Professor Babcock's laboratory at Berkeley, and it has been found well adapted for instructional purposes. The following data presented in Table I give results obtained recently at the two institutions.

The above pairs should exhibit a ratio of about 1:1, and they approach this ratio in all sets of data for all four characters. In only two cases are the deviations from the expectancies greater than the standard errors and those two are less than twice the standard errors.

A comparison of the two sets of data shows that they agree with each other and with the published map as closely as might be expected, in view of possible errors in classification and with due allowance for chance sampling.

In classifying the seedlings, a particularly careful examination should be made of all plants with respect to the red-green pair, since they are the only characters in the group which are likely to give trouble. Under conditions of little sunlight, some *B* plants may fail to develop red color noticeably. Any data which do not show an acceptable 1:1 ratio for *B*:*b*, are not included in the class total for general study.

In order to make this corn seedling material more generally available to teachers of genetics who may wish to use it, suitable stocks have been placed in the hands of Mr. George S. Carter of Clinton, Connecticut, to be added to his genetics laboratory supplies.

Literature Cited

1. Emerson, R. A. The genetic relations of plant colors in maize. *Cornell Univ. Agr. Exp. Sta. Memoir 39.* 1921.

2. Emerson, R. A., G. W. Beadle and A. C. Fraser. A summary of linkage studies in maize. *Cornell Univ. Agr. Exp. Sta. Memoir 180,* 83 p. 1935.

TABLE I. Second Chromosome Segregations Observed at Cornell and at the University of California.

		CORNELL DATA	CALIFORNIA DATA*		TOTAL COUNTS
Region					
0	Lg_1 Gl_2 B V_4	519	412	931	1844
	lg_1 gl_2 b v_4	501	412	913	
1	Lg_1 gl_2 b v_4	132	116	248	494
	lg_1 Gl_2 B V_4	132	114	246	
2	Lg_1 Gl_2 b v_4	167	110	277	547
	lg_1 gl_2 B V_4	163	107	270	
3	Lg_1 Gl_2 B v_4	244	229	473	973
	lg_1 gl_2 b V_4	259	241	500	
1 and 2	Lg_1 gl_2 B V_4	20	24	44	111
	lg_1 Gl_2 b v_4	23	44	67	
1 and 3	Lg_1 gl_2 b V_4	49	64	113	205
	lg_1 Gl_2 B v_4	54	38	92	
2 and 3	Lg_1 Gl_2 b V_4	81	63	144	248
	lg_1 gl_2 B v_4	59	45	104	
1, 2, 3	Lg_1 gl_2 B v_4	17	20	37	65
	lg_1 Gl_2 b V_4	11	17	28	
	Total	2431	2056	4487	4487

TABLE II. Percentage of Recombination.

	Region 1	Region 2	Region 3	N
Cornell results	18.0	22.3	31.8	2431
California results	21.3	20.9	34.9	2056
Combined data	19.5	21.6	33.2	4487†
Linkage summary (2)	19	19	33	‡

*Published with the permission of Professor E. B. Babcock.

†This is a larger total than that given in the linkage summary and may in the case of region 2 furnish a more accurate gauge of distance.

‡Not all 4-point studies.

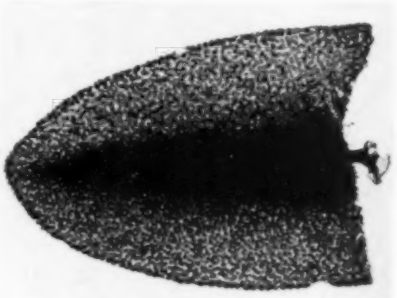
POLYPLOIDY IN THE SALAMANDER, *EURYCEA BISLINEATA*

GERHARD FANKHAUSER
Department of Biology, Princeton University

AMONG animals, a very limited number of cases of polyploidy have been recorded so far.[25] These can be divided into three categories: (1) In a few species of invertebrates, mostly arthropodes, polyploid races exist in nature; e.g., the triploid race of the land isopode, *Trichoniscus elisabethae*,[24] and the tetraploid race of the brine shrimp, *Artemia salina*.[1] (2) In moths, polyploid individuals may be produced by experimental means, by backcrossing species hybrids,[14] or by centrifuging eggs at the beginning of development.[17] (3) Polyploid individuals appear occasionally in diploid species, e.g., in Drosophila.[4] To this group also belong the occasional triploid individuals that have been found among preserved embryos of frogs and salamanders by various authors.[11]

The discovery of triploid specimens among normal amphibian embryos indicated that triploid larvae occur in nature. It was shown last year that in the common newt, *Triturus viridescens*, these exceptional triploid larvae may be identified in life by means of the "tailtip method." The tailtips of young larvae are amputated, fixed, and stained *in toto*. In the transparent fin surrounding the tail, mitotic figures are always present and allow a determination of the chromosome number of each individual. This method enables us, for the first time, to follow the development of triploid salamander larvae and to investigate the effects of polyploidy in a vertebrate.

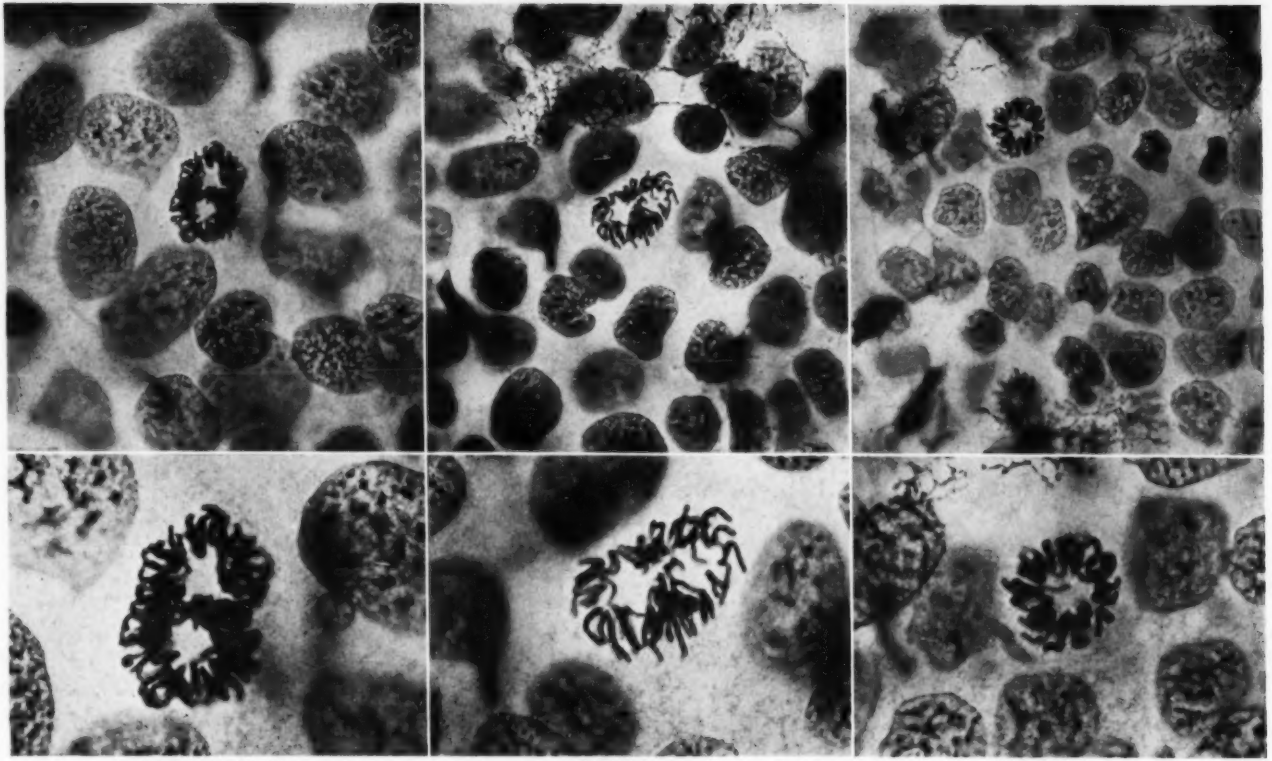
Last year, a total of 311 tailtips of Triturus larvae were examined. Five larvae were found to be triploid, with 33 chromosomes instead of 22. The frequency of triploidy in nature would thus be about 1.6%. Four of these triploids were raised through metamorphosis.



TAILTIP FOR CHROMOSOME COUNTS
Figure 15

An amputated tailtip, stained and mounted for microscopical examination. The darkly stained axis, containing muscles, nerve cord and notochord, is surrounded by a transparent fin. In the epidermis covering the fin, mitotic figures are always present. The chromosome number may be determined easily in late prophase and in metaphase (30×).

In view of the rather low frequency of triploidy in the newt, and of the difficulties encountered in raising any animals of this species beyond metamorphosis, a search was made for triploids among larvae of a lungless salamander, *Eurycea bislineata*. The larvae of this species do not metamorphose until the third year, nor do the animals pass through a strictly terrestrial phase after the transformation. It should therefore be easier to raise them to an advanced stage, possibly even to sexual maturity. On the other hand, the species offers cytological disadvantages which make the counting of chromosomes more difficult: the fin surrounding the tail is less transparent, the epidermal cells of the tailfin are considerably smaller, and the

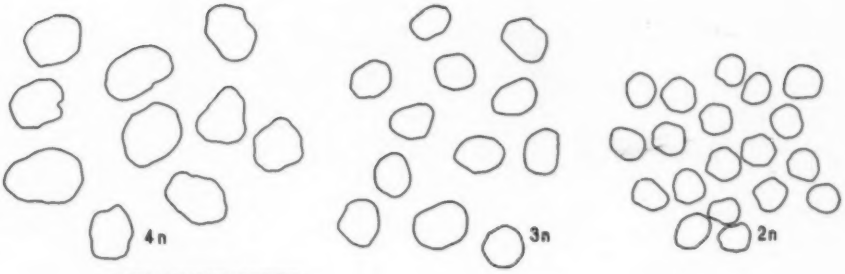


TETRAPLOID (4*n*) TRIPLOID (3*n*) DIPLOID (2*n*)

CHROMOSOMES IN THREE TAILTIPS

Figure 16

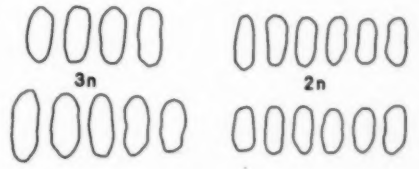
Small portions of the epidermis of a tetraploid, a triploid, and a diploid tailtip, each with a mitosis in metaphase (486×). Below, the three metaphase plates enlarged (972×). The chromosomes cannot be counted accurately in photomicrographs, but the dimensions and the general appearance of the whole chromosome group clearly indicate differences in chromosome number. The average size of the non-dividing nuclei is also roughly proportional to the number of chromosomes they contain.



RELATIVE SIZES

Figure 17

Outline drawings of epidermis nuclei from a tetraploid, a triploid, and a diploid tailtip, to show the parallel increase in chromosome number, nuclear and cell size. The latter is indicated by the wider spacing of the polyploid nuclei (292×).



BLOOD CELL NUCLEI

Figure 18 (Right)

Outline drawings of nuclei of red blood cells, from two triploid tailtips (left), and from two diploid tailtips (right) (716×).

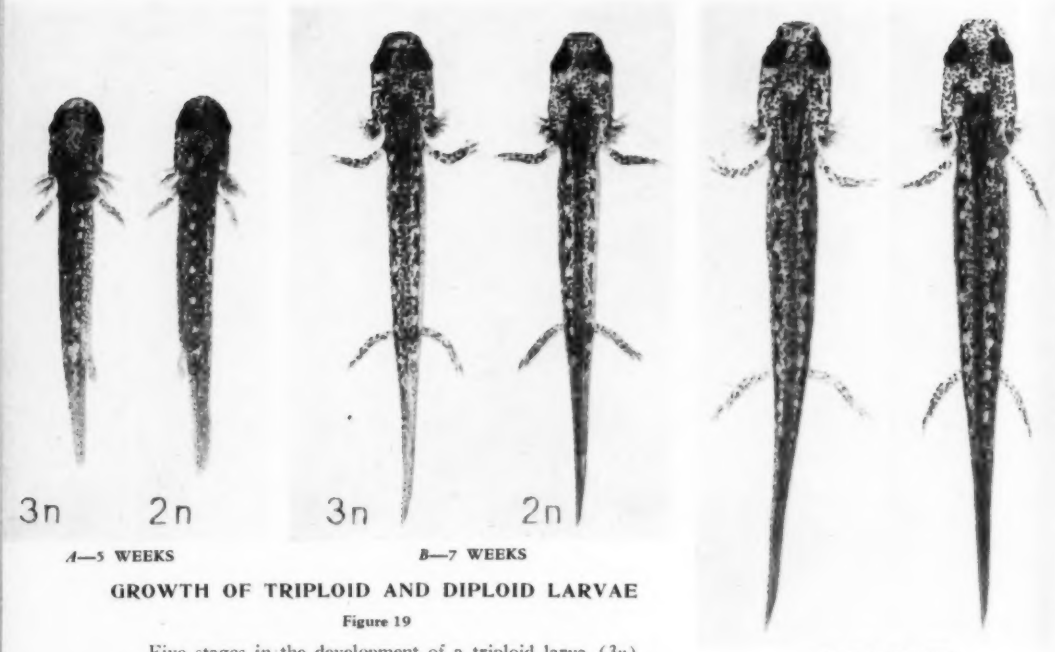
normal chromosome number is larger than in the newt.

Identification of Polyploid Larvae

Females with fully developed ovaries were collected in the vicinity of Princeton in November, 1938. While egg-laying normally does not occur in nature until May or June, it may be induced in the laboratory at any time by implantation of a single anterior pituitary lobe of a frog. Within forty-eight hours, the female deposits from forty to sixty eggs, fastening them to the underside of a rock. The eggs are usually fertilized since the female normally carries a store of spermatozoa in a receptacle connecting with the cloaca. The eggs were allowed to develop until the larvae hatched from the jelly capsules and a sufficiently broad fin had been formed around the tail. The animals were then isolated and the tailtips removed and prepared for microscopical examination (Figure 15).

No account of the normal chromosome number of *Eurycea bislineata* could be found in the literature. The counts made in the first two tailtips determined the diploid number as twenty-eight. The third tailtip to be examined already was triploid, with forty-two chromosomes in all analyzable figures. This early indication of a higher frequency of triploidy in this species was substantiated by later observations to an unexpected degree: of 134 larvae examined so far, 119 were diploid and 13 triploid. The remaining two proved to be tetraploid, with 56 chromosomes. These appear to be the first cases of natural tetraploidy to be found in vertebrates. Recently, Kawamura[18] discovered tetraploid and even hexaploid individuals among parthenogenetic frog tadpoles produced by puncturing unfertilized eggs of *Rana nigromaculata* with a fine platinum needle.

Figures 16 and 17 illustrate the difference in the appearance of tetraploid, triploid, and diploid metaphase plates found in the tailtips, as well as the striking differences in the size of the interkinetic nuclei which increases in direct proportion to the chromosome number. The polyploid cells as a whole are, of course, also larger, as is indicated by the wider spacing of the triploid and tetraploid nuclei. The general increase in



A—5 WEEKS *B*—7 WEEKS *C*—9½ WEEKS

GROWTH OF TRIPLOID AND DIPLOID LARVAE

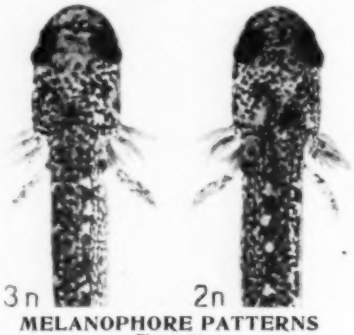
Figure 19

Five stages in the development of a triploid larva (*3n*) and a diploid control (*2n*), all at the same magnification (5×). The development and the rate of growth of the triploid are entirely normal. The larger size and smaller number of the pigment cells (melanophores) are the only visible signs of triploidy. At five weeks old (*A*), shortly after amputation of the tailtips and identification of the chromosome condition, the hindlegs are beginning to differentiate. Two weeks later (*B*), the food supply (yolk) originally contained in the egg is exhausted; the larvae are now fed on small Enchytraeus worms. At fifteen weeks (*E*), the difference in pigment pattern is still obvious. The triploid is slightly larger than the control.

nuclear and cell size can thus be used as a secondary criterion of polyploidy, supplementing the direct evidence from chromosome counts.

Appearance of Polyploid Larvae

In the living larvae, the larger cell size of the polyploids is demonstrated by the brown pigment cells or melanophores in the skin (Figures 20 and 23). The individual melanophores remain more distinct than in Triturus larvae, where they tend to form a rather dense network in later larval stages. In Eurycea, the differences in the pigment pattern caused by the increased chromosome number are clear enough to allow a tentative identification of polyploid larvae, which



MELANOPHORE PATTERNS

Figure 20

Anterior parts of the larvae from Figure 5*A* enlarged to show the larger size and particularly, the wider spacing and smaller number of the pigment cells in the triploid (left) (10×).

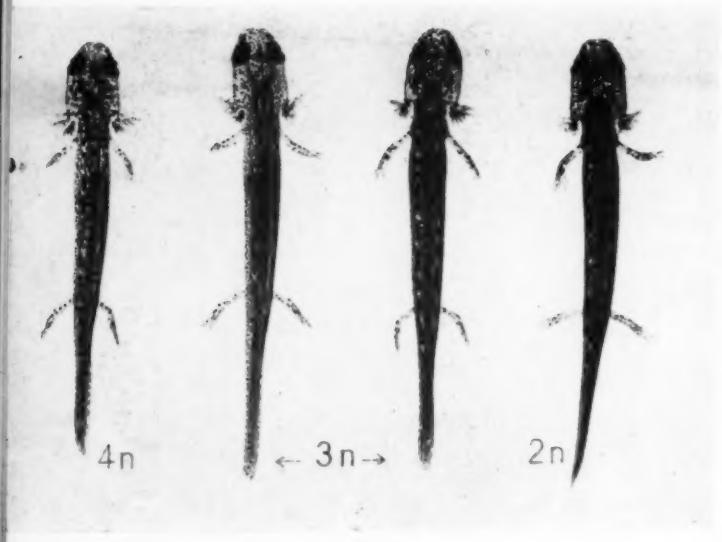
D—11½ WEEKS

E—15 WEEKS

can then be verified by chromosome counts. The size of the pigment cells alone is not a reliable index of the chromosome condition, since the individual pigment cells change their appearance with different degrees of dispersion of the pigment granules within the cells. The difference between 'contracted" and "expanded" melanophores is well shown on the heads of the two triploid larvae in Figure 21*B*. However, the wider spacing and the reduction of the total number of pigment cells in polyploid larvae remain, of course, unaffected by these changes and represent a more valuable criterion of polyploidy.

Aside from the pigment pattern, the development and general appearance of the triploid larvae are entirely normal. They are vigorous and grow at approximately the same rate as the diploid larvae (Figure 19). In later stages they may or may not become slightly larger than the controls (Figure 19*E*).

The two tetraploid larvae, from the beginning of the observations, appeared slightly smaller than the diploid (Figure 22) and grew more slowly. One tetraploid could not be induced to feed after the exhaustion of the yolk supply. Dur-



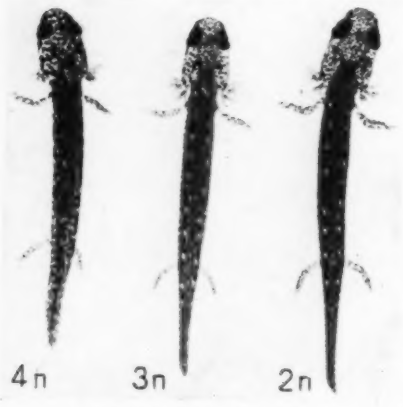
A—8 WEEKS

GROWTH OF TETRAPLOID

Figure 21

B—10 WEEKS

Three stages in the development of the second tetraploid larva (*4n*), two triploid larvae (*3n*), and a diploid (the same female. The tetraploid is the smallest of the four larvae. *A*—eight weeks old; *B*—ten weeks; *C*—thirteen



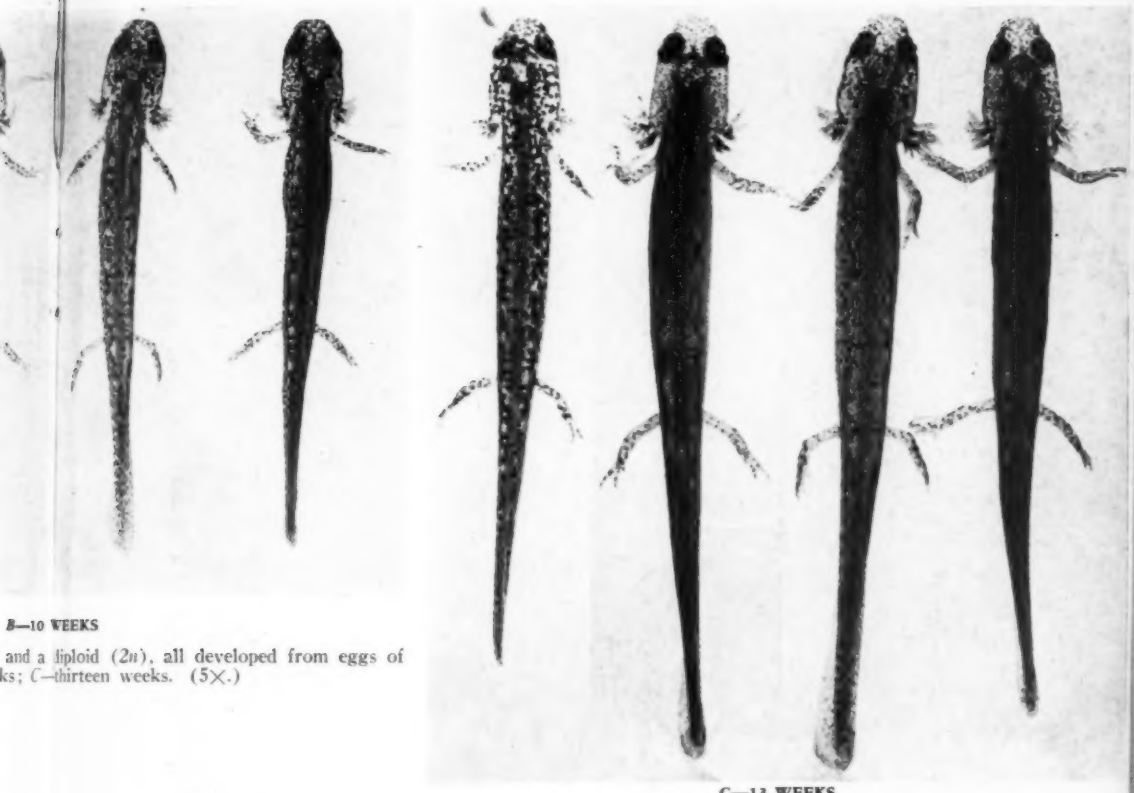
FIRST TETRAPLOID

Figure 22

The first tetraploid larva (left), together with a triploid (center) and a diploid (right), all developed from eggs of the same female, laid at the same time. Note the large size of the tetraploid pigment cells. Seven weeks old. (4.5×.)

ing several trials, spaced over two weeks, it did not show the slightest interest in a rapidly squirming worm which aroused an almost instantaneous snapping reaction on the part of all diploid and triploid larvae at the first trial. It was therefore preserved at the age of nine weeks. At present, the other tetraploid feeds well and takes about the same amount of food as the other larvae. Its reactions are, however, decidedly slower, and it remains behind in growth (Figure 21).

In Eurycea, polyploidy is thus not connected with gigantism, as in the majority of plants and in some animals, like Trichoniscus.[24] Of the four triploid larvae of *Triturus viridescens* raised last year, only one showed a striking increase in body size.[11] The examination of serial sections through the other three revealed that all organs, with the possible exception of the notochord, contain larger, but fewer cells.[13]



B—10 WEEKS

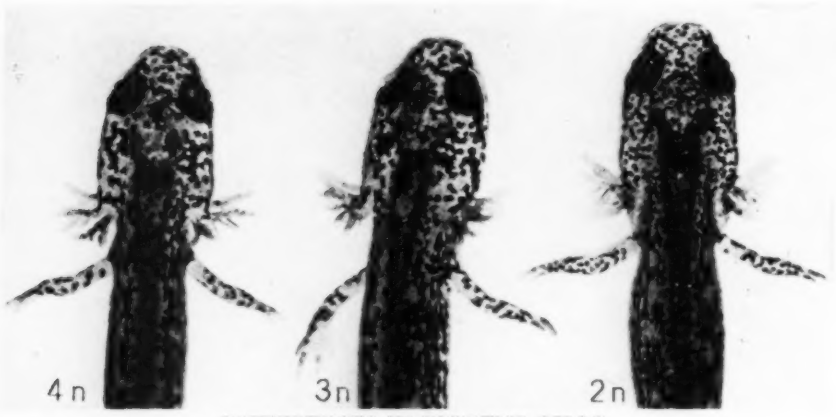
and a diploid (2*n*), all developed from eggs of
ks; *C*—thirteen weeks. (5×.)

C—13 WEEKS

We may, therefore, expect that the tetraploid Eurycea larvae have only half the normal number of cells of twice the normal volume. This is clearly indicated by the pigment cells in the skin, and by the epidermal cells of the tailtip. If this condition applies to all organs, it might lead to harmful consequences. The number of red blood cells, and thus the oxygen-carrying power of the blood would be reduced. Brain and spinal cord would contain only half the normal number of ganglion cells, and this might in turn affect the functioning of the nervous system. In the retina of the eye, we would find only half the normal number of visual cells, so that the visual acuity of a tetraploid animal should be below normal. In general, the larger cell size in all organs would tend to interfere with the rapid exchange of substances between center and surface of individual cells.

Effects of Triploidy on Sex

In animals with a definite sex chromosome mechanism, triploidy has a striking effect on sex. While the homogametic sex is normal, the heterogametic sex is changed to an intersexual condition,[4, 15] since the normal 1:2 ratio between a single *X* chromosome and two sets of autosomes cannot be attained in a triploid individual. In amphibians, the sex chromosomes do not appear to be visibly differentiated from the autosomes. The evidence from crosses between normal frogs and occasional her-



DIFFERENCES IN PIGMENT CELLS

Figure 23

The anterior parts of a tetraploid, a triploid, and a diploid larva, enlarged to show the increase in size, and decrease in number, of pigment cells that go parallel with the increase in chromosome number. (9×.)

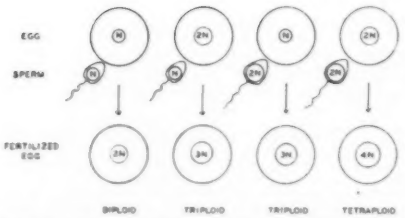
maphrodites[6, 26] indicates that the male sex is heterogametic, while the results of extensive experiments on sex reversal in toads[21] point in the opposite direction.

Under these circumstances it is all the more important to investigate sex differentiation in triploid salamanders. Of the four triploid Triturus preserved after metamorphosis, one appears to possess normal testes, while the other three have ovaries which are clearly underdeveloped as compared with normal ovaries of diploid animals.[12] This seems to indicate that, in the American newt, triploidy affects the female sex rather than the male. However, at the time of metamorphosis, the ovaries and testes of Triturus are still in an early stage of development which does not allow a clear diagnosis of an intersexual condition. From this standpoint, triploid Eurycea larvae should be more satisfactory material, since they can be raised more easily to a stage in which the gonads as well as secondary sexual characters are well differentiated.

Origin of Polyploidy

Triploid animals appear to originate usually from the union of a diploid, unreduced gamete with a normal one (Figure 24). Diploid eggs have actually been found in frogs.[2, 23] On the other hand, groups of tetraploid cells have been seen in otherwise normal testes in several species of animals.[5, 7, 8] Such cells may produce diploid spermatozoa and these, penetrating into haploid eggs, would also give rise to triploidy. On rare occasions, two exceptional, diploid gametes should meet and produce a tetraploid animal. The relative frequencies of diploid, triploid, and tetraploid larvae of Eurycea, 119 : 13 : 2, would be in agreement with such an explanation. Polyspermy and somatic doubling of chromosomes may also play a role in producing triploid and tetraploid embryos, respectively. Cytological investigations are in progress to determine more accurately the causes of natural polyploidy in salamanders.

Investigators of polyploidy in plants have recently emphasized the importance of physiological effects of the increased chromosome number, as well as the appearance of qualitative morphological changes in addition to quantitative manifestations.[3, 9, 16, 19, 20, 22] Further analysis of the consequences of polyploidy in salamanders promises important information in both these directions.



PROBABLE ORIGIN OF POLYPLOIDS

Figure 24

Normally, both egg and sperm contain a single haploid set of chromosomes (*N*). Occasionally, egg cells occur with the diploid chromosome number (*2N*). If fertilized by normal, haploid sperms, they give rise to triploid embryos. The reciprocal combination, fusion of a normal, haploid egg with an exceptional diploid sperm, would also produce a triploid animal. If two exceptional gametes meet, a tetraploid embryo would result.

Polyploid individuals may occur among other classes of vertebrates, but a satisfactory demonstration of their existence will meet with considerable cytological difficulties. Salamander larvae, with large cells and chromosomes and with removable tailtips, offer a unique opportunity among vertebrates since experimentally produced, haploid larvae are also available for comparison.[10] Furthermore, there is perhaps no other group of animals in which the details of normal development have been worked out so thoroughly and analyzed to such an extent by experimental methods. A combination of cytogenetical and embryological procedures may well lead to a new phase in the analysis of polyploidy.

Summary

1. The diploid chromosome number of *Eurycea bislineata* is 28.

2. Triploid and, more rarely, tetraploid larvae occur in nature. They may be discovered while developing normally, by chromosome counts and by comparison of nuclear sizes in amputated tailtips. Polyploid larvae may be identified tentatively by the larger size, wider spacing, and smaller number of pigment cells.

3. Of 134 larvae examined so far, thirteen were triploid and two tetraploid.

4. The triploid larvae develop and grow normally. They may or may not become slightly larger than the controls. The tetraploid larvae are slightly smaller than the diploid and grow more slowly.

5. As in triploid larvae of the newt, *Triturus viridescens*, gigantism of polyploid Eurycea larvae is prevented by a reduction in cell number which compensates the increase in size of the individual cells.

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THE SEX RATIO IN DOGS MAINTAINED UNDER SIMILAR CONDITIONS

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SEVERAL studies have been made and published dealing with the sex ratio in dogs. The principal studies have dealt with greyhounds in England[1,2] and German Shepherds in Germany.[4] Schmaltz[3] cites Wilkins as showing that the proportion of males to females in dogs is 110:100. Combining the figures of Heape and Dighton for greyhounds, the figures for 25,374 dogs born was 115.8 males to 100 females. My own studies with German Shepherds, which figures were derived from the official registry for the breed and covering 49,650 dogs, was 106:100.

Repeatedly the point has been debated whether the proportion of males to females can be influenced by certain factors such as food, climate, breeding at various times of the year. In fact, over two hundred theories have been postulated and in each case the originators of the theories have proved to their own satisfaction that what we today consider theory was to them definite fact.

What influences are at work, if any, to modify the sex ratio, is always a matter of interest on which to speculate. In using records from kennel clubs or registry associations many factors must be taken into consideration. Naturally the dogs recorded in kennel association records have been fed on wide varieties of foods; have been kept under a wide variety of kennel and climatic conditions and therefore, in studying the sex ratio one studies a composite of extremely varied conditions. It has seemed to me that it would be interesting if we could take the figures from at least one fairly large group of dogs, which had been raised under as nearly uniform conditions as possible.

In my own kennels considerably over 5,000 puppies have been whelped, but of these a much smaller number has been whelped when the parents have been fed on the same food; many having been used in food testing experiments. Therefore, I went through the records carefully and selected all of the litters born to parents which had been fed the same food and also selected only those puppies whose parents had been raised from puppyhood in my kennels and had been mated to dogs which had lived at least a year in the kennels. All others were rejected. This was done in order to eliminate as many outside influences as possible and thus, within certain limits, to choose a group of puppies conceived under relatively similar conditions. All of

my dogs are kept out of doors the year around with no artificial heat in their kennels. In all, 1,440 dogs were born to parents which had been kept under these fairly uniform conditions of feed and care. The sex ratio of this number of puppies was 124.3 males to 100 females. Table I shows the births by months.

The figures for the total number has been broken down by months. During some of these months the figures are doubtless too small to be significant, although they are indicative. The gross figures for the year and for the two half-years are, I believe, significant.

It is interesting to note that the puppies conceived during the warm months of the year show a sex ratio, males to females, of 116:100, whereas those conceived during the colder months of the year show a sex ratio of 143:100.

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TABLE I—Sex Ratio of German Shepherds Maintained under Similar Conditions

Birth Months	Males	Females	Ratio Males to 100 Females	Oestrus Months	
December	40	33	121	October	
January	88	52	169	Nov.	
February	50	41	122	Dec.	Average ratio for colder months
March	34	24	141	January	143.1 Males:100 Females
April	34	26	130	Feb.	
May	53	32	165	March	
June	78	64	122	April	
July	114	97	117	May	
August	84	74	113	June	Average ratio for warmer
September	36	28	128	July	months 116.1 Males:100 Females
October	76	69	110	August	
November	111	102	108	Sept.	
	798	642			

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COLCHICINE TREATMENT OF PINE SEEDS

THE recent work of Blakeslee and Avery* on the induction of polyploidy in angiosperms by the use of colchicine has received widespread attention. The significance of this work and its possible application to practical plant breeding have induced many workers to duplicate the experiments with other plant material. Such experiments were undertaken by the Institute of Forest Genetics in the genus *Pinus,* in which polyploidv is unknown.

Seeds of *Pinus ponderosa* were held in moist sand at 5° C. for three months to insure rapid and uniform germination. They were then placed in the greenhouse for germination, and when the seed coats were split by pressure of the developing embryo the seeds were placed in a Petri dish on three sheets of filter paper that had been moistened with 0.2 per cent of aqueous solution of colchicine. After five days the seeds were washed in water and planted in pots of soil on the greenhouse bench.

Development of the treated seeds was considerably delayed, as compared with untreated material. The effect of the treatment was not uniform: some of the plants were of normal appearance, while others were greatly deformed. In general, the seedlings were weak, with swollen crowns and club-shaped cotyledons. After three weeks entire seedlings were

*Blakeslee, A. F., and A. G. Avery. (1) *Science* 86:408. 1937; (2) *Jour. Heredity* 28:393-411. 1937.

killed and fixed, embedded in paraffin, sectioned, and stained.

Microscopic examination corroborated the fact that some plants were more affected by the treatment than others. In some plants cell structure was apparently normal, and except for a depressed growth rate no changes were visible. In other plants the cell behavior was greatly deranged and varied. The meristem was more diffused than in normal plants, and dividing cells were elongate and few in number. The chromosome number varied from 24, which is normal in somatic tissue, to ca. 96 in multiples of 12. Spindle formation was inhibited in some cells, and formation of the cell wall was lacking or was vestigial and ineffective. The largest chromosome numbers were observed in secondary or tertiary derivatives of the apical meristem. In other cells spindle formation was deranged but not inhibited, and multipolar spindles and diffuse spindles resulted. At metaphase the long axis of the cell often lay within the equatorial plane of the chromosome plate. A realignment of the chromosomes between metaphase and anaphase resulted in a grouping of the chromosomes near the ends of the cell at anaphase. Cell-wall formation then occurred in the equatorial plane of the spindle.

It is doubtful whether these partially polyploid pines will be of practical value, but the results indicate that it may be possible to produce stable polyploid plants that can be used in plant breeding.

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THE FLORAL FACTS-OF-LIFE

"THE present volume is intended as an introduction to the study of the structure, development and functions of the flower" — this from the preface to *Floral Mechanism** by S. G. Jones of the University of Glasgow. The intention is good: such a book has a place. In Part I (pp. 1-144), Doctor Jones writes of the morphology and anatomy of flowers and inflorescences, of the sexual cycle in angiosperms and of its genetic and cytological aspects, of heredity and evolution, and of plant breeding; in Part II (pp. 145-255), he demonstrates the "keying" of a plant to its taxonomic group and discusses systematically twenty-one selected families of monocotyledons and dicotyledons. He includes in the book seventy-two full-page figures, all but two being original, and two pages of pictures taken at the Welsh Plant Breeding Station, Aberystwyth. There is a limited bibliography (p. 256), an inadequate glossary (pp. 257-260), and a fairly complete index (pp. 261-274).

Floral Mechanism is interesting, informative, elementary, thought-provocative: all that. The illustrations are good; they are well done and have a freshness that stimulates: one tires of publications in which most of the figures, though excellent, bear legends reading "after Baillon" or "after" some other worthy whose figures are more or less familiar. I am glad the book was written; I shall find it useful. But it has its faults, naturally: some of them are serious, surprisingly so, — especially in an elementary text. The terminology sometimes lacks precision, and words are used loosely. At other times the phraseology is roundabout, rambling, awkward. Not infrequently the manner of expression suggests purposive adaptation on the part of plants. The "facts" and unqualified statements are often open to question. Only a part of the evidence is sometimes given: Doctor Jones, as a rule, does not present alternative interpretations.

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*Jones, S. G. *Floral Mechanism.* Chemical Publishing Co., Inc., New York. 1939. (Printed in Great Britain.)

FAMILIAL RESEMBLANCES IN COMPOSITES OF DESIRABLE TRAITS*

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MEASUREMENTS of parent-child resemblance and sibling resemblance have (without exception, I think) been limited to one trait at a time. We have, that is, the correlation coefficients for height, eye-color, I.Q., etc., but not for composite scores for several physical features, or several mental traits. It is desirable, especially for certain practical problems of improving populations by selective breeding, to know the latter. In the case of mental and moral qualities the determining genes are apparently so many and so complexly related that selection for general average excellence must be a main feature of any scientific eugenic program. We need therefore to know the magnitude of familial resemblances in such measures as a weighted composite or average of scores in standard tests of honesty, service, self-control, etc., in physical health, in mental health and balance, and in desirable esthetic traits.

If the variance in the traits in question is caused by a number of genes (with or without further influence from various circumstances of life) so that the distribution occupies a fairly large number of continuous steps on a linear scale, the resemblance of related persons, say of siblings, in such a general excellence score will be higher than the average of the resemblances in its constituent elements taken one at a time. This results from the fact that the intercorrelations of desirable traits in the general population are below unity, often far below it, and from the following facts: If parents *P* 1 and *P* 1a had an infinite number of offspring, the average score of a random half of the offspring would correlate perfectly with the average score of the other half in any trait and in any combination of traits, whether caused by genes or by the circumstances of life, when put into a correlation table with other such sets of offspring from parents *P* 2 and *P* 2a, *P* 3 and *P* 3a, etc., to *P* 1000 and *P* 1000a. If now we take a single sib at random from each random half of each set of offsprings, the correlations will be reduced below unity because in genes or in the circumstances of life or in both the sib diverges from the average of the random infinite half whence he came. His divergences from it, item by item, will vary in direction and magnitude. The average of his divergences in two items (regarding signs) will in the long run be less than the average of the two divergences (regardless of signs). Similarly for three, four, five, etc., items.

This argument and its assumptions are probably dependable, but it will be safest to check them. In any case we need knowledge of the amount of the increase. I have measured it in the case of 93 male sibling pairs (every pair being used in families having more than two siblings) from European royal families, the measurements being ratings for "intellect" and "morality" made by five or more persons who read the descriptions of the persons concerned given in various encyclopedias, with no knowledge of the family relationships of any person. Such ratings are defective in many ways, but for our purpose their defects are not serious. The average of the correlations for "intellect" and for "morality" is .505; that for a composite

*The work reported here was done incidentally in the course of a general program of research supported by a grant from the Carnegie Corporation.

of intellect and morality with approximately equal weight (1 and 1.2) is .57. The difference of .065 has a large ostensible error ($\sigma = .10$) but this is in part spurious because the pairs are the same in all three correlations.

These correlations are computed by using deviations from the medians of the persons concerned. These royal families are probably much above the general run of the population in intellect and somewhat above it in morality, so that the first and third corresponding correlations for a random selection of male siblings would probably be substantially higher; but the relative difference of the composite from its elements would be about the same. The main danger in taking this case as a fair sample of sibling correlations for a composite of desirable traits lies in a possible tendency of biographers to make opposite errors concerning intellect and morality in their descriptions of a person. Such would in and of themselves make the correlation for the composite higher than the correlation for either constituent. The persons who made the ratings from reading the biographies made those for intellect and morality independently and weeks apart, and would be afflicted by few save chance errors. Combining the ratings of five or more persons gets rid of most of these. If they had any constant error, it would presumably be toward the "halo" effect of assimilating intellect and morality scores for an individual. The correlation between the intellect score and the morality score for the same individual is .54, which is not much lower than would be expected from accurate measurements of the two traits.

I have also computed the resemblance of 46 pairs of twins in (1) a measure of ability to find misspelled words, nonsense words containing certain pairs of letters, and *A's* on sheets of printed capitals, (2) a measure of ability in addition, multiplication, and giving the opposites of words, and (3) an equally weighted composite of (1) and (2). The three correlations are in order .667, .784 and .78. The rise should be small in this case because the "identical" twins among the 46 pairs would, according to orthodox doctrine, show a very high resemblance in any feature taken and would dilute the phenomenon which we are considering. It is in fact 4.5 points [from .735 for the average of (1) and (2) to .78 for (3)].

This note is written in the hope that certain colleges have available scores in intelligence tests, scholarship, health, and certain special abilities for a hundred or more sibling pairs which some one will use to answer the general question. It seems probable that breeding for general excellence will produce much more rapid improvement than has been expected on the basis of the fraternal correlations for single traits.

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Civil Service Wants Statisticians

Unassembled examination No. 104 is announced for October 16, 1939, for statisticians of various grades in eight subjects: 1. Economics, 2. Mathematics, 3. Public Health, 4. Sociology, 5. Social Service, 6. Public Administration, 7. Biological Science, 8. Engineering and Physical Science. Salaries range from $2,600 to $5,600 per year. Details and application forms may be obtained from the Civil Service Commission, Washington, D. C.

CHROMOSOME DOUBLING IN THE CEREALS*

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THE production of polyploid individuals in the higher plants by the action of colchicine has been reported by several workers[1,2,4,6] during recent months. The species in which chromosome doubling has been accomplished include a comparatively wide range of the plant kingdom. The writer became interested in applying this process and the results that have been obtained with certain of the small cereals are given in the following brief account.

The seeds were germinated at a temperature of about 18° C. When the young shoots were one-eighth to one-fourth of an inch in length the germinating seeds were immersed in a 0.25 per cent aqueous solution of colchicine for twenty to thirty minutes after which they were removed, planted in the greenhouse and allowed to develop. In oats and barley the hull was removed from the caryopsis before treatment. In many individuals the coleoptile became much enlarged and shortened, a small first leaf was formed and the meristematic tissue of the central axis was killed. Sectors of polyploid tissue were present in some of the individuals which survived and tetraploid lines were established from the seed which were produced in these sectors.

The tetraploid individuals were detected by (1) chromosome counts in cross sections of root tips which were prepared by the paraffin process and stained with crystal violet, (2) the size and distribution of stomata in the dorsal surface of the leaves, and (3) where possible, comparison of size of pollen

AN INDUCED TETRAPLOID IN OATS

Figure 25

Diploid (left) and tetraploid (right) plants of *Avena brevis*. Note the difference in time of heading.

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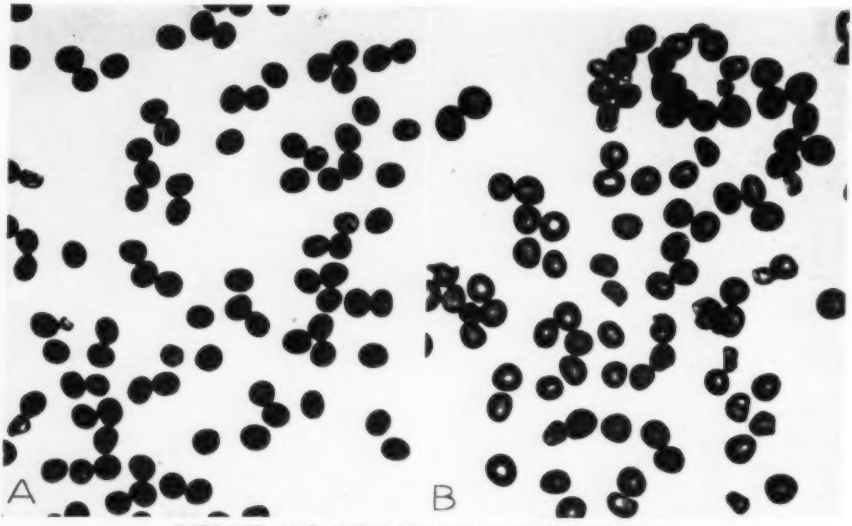
†The writer wishes to acknowledge his indebtedness to Dr. L. F. Randolph of Cornell University for assistance and suggestions.



DIPLOID AND TETRAPLOID BARLEY POLLEN

Figure 26

Size difference in the pollen of diploid (*A*) and tetraploid (*B*) *Hordeum vulgare*. (Wisconsin No. 38.)

grains in the diploid and tetraploid individuals.

A brief account of the induced tetraploids follows:

1. *Triticum monococcum*. Einkorn. A sector of polyploid tissue which constituted approximately one half of a plant was obtained from seeds which were treated in December, 1937. The central axis of the plant died soon after tillering began. The plant tillered profusely and in the spring of 1938 there were 24 tillers with diploid tissue and 28 tillers with tetraploid tissue. No mature spikes were obtained from the tetraploid tillers though in two instances immature heads were formed both of which decayed before emerging from the sheath. The doubled portion of this plant was separated into several parts during the summer of 1938 and three of these are now alive. Sections of three root tips show 28 chromosomes and the texture of the leaves and the size of the stomata and their distribution indicate doubling.

2. *Avena brevis*. Three culms were obtained from seeds which were treated in the spring of 1938. Each of the culms produced several seeds from which twelve plants were obtained. The cells of the root tips have 28 chromosomes and the size and distribution of stomata indicate that they are tetraploid. The twelve plants compare favorably with diploids in regard to height, vigor and tillering. The time of heading of the tetraploids will be appreciably later than the diploids. (Figure 25.)

3. *Hordeum distichon*. Alpha. A single spike which came from seed treated in 1938 yielded nine seeds. These were planted in the greenhouse in March, 1939. Cross sections of root tips from the seedlings show 28 chromosomes.

4. *Hordeum vulgare*. Wisconsin No. 38. From seeds which were treated in 1938, one spike was obtained which bore seven seeds. Each of these produced plants of which two are diploid, four are presumably tetraploid (28 chromosomes) and one has 31 chromosomes. The latter is dwarfish and has tillered profusely. All of the tetraploids have produced spikes with seeds though the set of seed is imperfect.

The variation in the somatic numbers is significant. Müntzing[3] has reported a similar variation in the somatic numbers in the progeny of a tetraploid barley (*H. sativum*) and believes that the variation is associated with irregularities which occur during meiosis. A similar variation has been found by the writer in the progeny of a spontaneous tetraploid barley which originated in the progeny of the cross of the varieties Trebi × Club Marioux (C. I. No. 6151, Office of Cere-

al Investigations U.S.D.A.). Six seeds of this tetraploid were planted in the greenhouse in December, 1938, for observation. Five of the plants from these seeds have 28 chromosomes while the sixth definitely has 31 chromosomes. Randolph[5] has reported similar variations in tetraploid maize.

Summary

Tetraploids of *Triticum monococcum, Avena brevis, Hordeum distichon* and *H. vulgare* have been produced by means of the action of colchicine. With the exception of *T. monococcum* the results reported above are based upon the study of the second tetraploid generation.

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MAKING FIGURES TELL THE TRUTH

PROBLEMS of field crops and horticulture are analyzed in this book,* by an author who is well versed in agronomy. From a statistical point of view it is elementary. It is written to explain to research biologists who have had little training in statistics how to use them in their work; without going into the mathematical theory of statistical procedures. The subject matter consists of basic formulae, analysis of variance and covariance, contingency tables and goodness of fit, correlation and regression; field experiments including such designs as randomized blocks, Latin squares, split-plots, et cetera. Seven frequently used statistical tables are included in the appendix.

The book is outstanding in presenting the material in a simple, readable manner readily comprehensible to the layman. The only difficult chapter is that on recent developments in field experiments, which is given more to cover the subject completely than to serve as a guide in conducting such experiments. Each subject is introduced with a discussion of the principles involved, followed by a simple demonstration of the technique of calculation, and finally an interpretation of the results. All calculations can be followed without the use of a machine. At the close of each chapter the useful formulae are summarized to facilitate reference.

Especially practical are the suggestions on field experimentation, with standard designs and methods of handling perennial crops discussed in detail. This section includes methods that can also be used in orchard experimentation.

In explanations of statistical techniques exactness has been somewhat sacrificed to secure simplicity, and general and special methods of analysis have not been made distinct. The examples as presented, however, are correct. In illustrating the method of comparing a single variety with other varieties in the test, no account was taken of the fact that the mean of the variety being tested is part of the general mean.

Concerning differences that do not reach the five per cent probability point, some of the wording helps perpetuate the all-too-common confusion between a difference which is zero and a difference which, although not statistically significant by the conventional standard, certainly is not zero. Thus, on page 18 we read: "The conclusion would therefore

(*Continued on page* 400)

*Paterson, D. D. Statistical Technique in Agricultural Research. 263 pp. McGraw-Hill Book Company, Inc. New York. 1939.

DO THE MODES OF TRANSMISSION OF TUMORS VARY?

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IT is unfortunate that, in the discussion of the rôle played by heredity in causing tumors, there has been such a variety of opinion among workers in this field that the onlooker has tended to forget that there is much common ground in the viewpoint of these people, namely that there is an hereditary background in many cases of tumor development, and that much of the bickering among the specialists concerns detail, rather than fundamentals. In the earlier phases of the development of the science of genetics, certain traits were said to be dominant, some recessive, etc., and once the mode of transmission of a trait was determined, it was supposed that it was settled for all time. Gradually this idea has changed, and it is now recognized that what is a so-called dominant in one stock, may be recessive in another. If a single trait such as eye color or eye size be capable of exhibiting different modes of transmission in different species, or even in different stocks in the same species, one need not marvel that tumors of different organs or that different types of tumors exhibit different modes of transmission.

It is true that conclusions drawn from human data, where the matings are not experimentally controlled, and where autopsy or biopsy is not always used to confirm the diagnosis, are not as reliable as those drawn from data where the matings were controlled and the diagnosis based upon histological examination. Nevertheless, certain deductions can be made with a reasonable degree of accuracy, and it is the purpose of this paper to analyze the data with respect to two types of tumors, and show that the tumors are inherited according to different rules of transmission.

We choose for discussion two tumors, both of which appear in early childhood, and hence whose biometric analysis is not complicated by the loss of potential tumor patients through death before the tumor has time to develop; also the opportunity for environmental factors to act as causative agents is decidedly lessened, because the tumors occur early in childhood, especially the tumor of the eye. The first is the cancerous degeneration of the skin accompanied by hypersensitivity to light. From an analysis of the cases of xeroderma pigmentosum found in the literature[5] it is evident that males and females are affected equally; that the parents are nearly always unaffected, since the disease is one that is almost universally fatal before the victim reaches adult life; that the parents are related more than 100 times as often as parents in the general population, and that the percentage of affected children agrees very closely with the number expected on the hypothesis that the defect is dependent upon homozygous recessive factors, not linked with sex. Haldane lists xeroderma pigmentosum as an incompletely sex-linked character in man. He defines as incompletely sex-linked those characters which are handed down by a heterozygous male to offspring of the same sex as the parent from whom he received the defective gene rather than to offspring of the opposite sex. Such genes are located in the homologous part of the sex chromosome. In the records dealing with xeroderma pigmentosum that I have collected from the literature, there were practically no instances of an affected male passing on the defect, for the disease is usually fatal before the age of marriage is reached. Almost all cases were examples of affected children, both of whose parents were free of the disease.

The second tumor is one which also occurs in early childhood and is also very rare, namely, retinoblastoma. From data gathered from many eye hospitals, it is estimated that between one in every 10,000[4] to one in every 2,500 patients[5] in eye hospitals has retinoblastoma. Not every person becomes a patient in an eye hospital, but I have chosen a very conservative number in order to illustrate the method of reasoning. I have assumed that about one in ten persons is a patient in an eye hospital, and that one in every 2,560 patients in the eye hospital has retinoblastoma. Thus about one in every 25,600 persons in a population might be expected to develop this eye tumor. The proportion may be far less than that, but we will use that figure for the first analysis.

Analysis of Data

Assuming retinoblastoma to be due to a recessive factor

Let us suppose that retinoblastoma is inherited according to the same scheme which we have found so accurately explains what we observe to be true in xeroderma pigmentosum. How closely does that assumption for retinoblastoma fit the facts? If one in every 25,600 persons has retinoblastoma, and if it is recessive we can estimate with fair accuracy the number of persons who are heterozygotes and also the number who are wholly free of the defect, provided that random mating has obtained in the population. There will be, if retinoblastoma is dependent upon a single recessive, two types of mature germ cells, those which contain the factor for retinoblastoma and those which do not. Let p equal the proportion, expressed as a fraction of mature germ cells (with the haploid number of chromosomes) which are without the factor; and q equal the proportion with it. Then p plus q equals 1; and p^2 plus $2\ pq^2$ plus q^2 also equals 1. Now q^2 represents the number of fertilized germs cells which contain two factors for retinoblastoma; and if it is recessive, also the number of persons with the defect. This we have estimated to be about 1/25,600. Therefore q equals the square root of that number, or 1/160. Since p plus q equals 1; p must equal 159/160. Therefore p^2 equals 25,281/25,600, the number of persons who are wholly free of the defect; and $2\ pq$ equals 318/25,600 and is the percentage of carriers or heterozygotes in the population.

Call the first group, p^2, DD, and the second, $2\ pq$, DR and the third q^2, RR. We can now estimate the possibility of these three types of persons mating at random. That is expressed by the square of the expression DD plus DR plus RR. We are concerned only with two of the six possible types of matings, for $DD \times DD$, $DD \times DR$ and $DD \times RR$ will produce no offspring with retinoblastoma if it is dependent upon a recessive factor. We need not discuss the $RR \times RR$ mating, for I have never encountered a record where husband and wife both had retinoblastoma. We will study only the $DR \times RR$ and $DR \times DR$ matings. The first is exemplified by the matings in which a person who had the eyes removed for this tumor in childhood survives, marries and has children with the disease. The second occurs when two normal persons mate and have affected offspring. Now there are 318 DR persons in every 25,600 of the population, according to our assumption. Therefore, two such persons are apt to mate according to the square of that expression, $(318/25600)^2$. The other mating ($DR \times RR$) occurs according to the expression $\frac{2\ (318)}{25600^2}$. The first type of mating between unaffected persons will, therefore, occur 159 times as often as the second type which is between an unaffected and an affected person.

What do we find in actual experience? In 302 matings which produced offspring with retinoblastoma, 18 or six per cent were of the $DR \times RR$ type. Thus this latter type was occurring about 10 times too frequently for the hypothesis that retinoblastoma was dependent upon a recessive. But might this six per cent have occurred in this particular group by chance, and if we had another group of 302 might the incidence of this type of

mating have been lower? If the probability is one in 160 that a mating producing children with retinoblastoma is a mating between unaffected and affected persons; and if the probability is 159 times in 160 that the parents of affected children are both unaffected, then we can calculate whether this six per cent was likely to occur by chance or whether it was likely to be due to the fact that our primary supposition was wrong, namely, that retinoblastoma was dependent upon a recessive factor. One mating in 160 is approximately 0.6 per cent, and 159 in 160 is about 99.4 per cent. In a group of 302 matings might one encounter by chance as many as six per cent instead of 0.6 per cent of matings between unaffected and affected persons?

Calculating the standard deviation shows that this figure is 0.44. Twice that amount might still be encountered by chance, so we double that and get 0.88. Therefore in a group of 302 matings where, on the average, we should expect 0.6 per cent of them to be of the type $DR \times RR$, we could expect to find as many as 1.48 per cent (0.6 + 0.88) or none at all of this variety. But we found 6 per cent of the matings of this type. The difference between the expected value of 0.6 per cent and the observed value of 6 per cent, is 12.3 times as great as the standard deviation or error. Therefore, it is extremely unlikely that this departure from the expected value is due to chance.

Let us choose for the analysis an incidence of retinoblastoma as one in every 90,000 in place of one in every 25,600; this incidence corresponding more closely to the figure of incidence of one in every 10,000 patients with retinoblastoma. Making a similar set of calculations as was done in the first analysis, we should find that the deviation of the observed from the expected value was 17.4 times as great as the standard deviation, and still less likely to be due to chance.

It is, therefore, very improbable that the first hypothesis with which we started namely, that retinoblastoma was detendent upon a recessive factor, was correct, since it disagrees so widely with what we would find if the condition were due to a recessive gene.

Proportion of Families With One Affected

Another fact that is of value in the determination that retinoblastoma differs from xeroderma pigmentosum in its mode of transmission is this. In the majority of cases, the affected person is the only one in the family affected. In a series of 169 cases reported from the Royal London Opthalmic Hospital taken consecutively over the two periods 1871-1904, 1915-1924, there were apparently only two instances in which there were others in the family affected.[7,1] (I have not the data for the years 1904-1914.) In 48 cases reviewed by Hemmes there was only one in the family affected. Now if retinoblastoma were dependent upon a single pair of recessive factors, there should have been far more families with several children affected. Thus in two-child families in which a recessive defect appears, we expect to find one family in seven with two affected; in three-child families we should find on the average, at least one in four (1 in 3.7) with more than one affected; and in four-child families almost two families in five will have more than one affected.[6] Thus the larger the number of children in the family the more apt there are to be more than one affected. To find in a series of 169 cases such as those just mentioned only two families in which more than one child was affected would in itself speak against the theory of the condition being dependent upon a recessive gene; for these families were collected at a time when large families were the rule.

Cousin Marriages

In the case of a defect as rare as retinoblastoma, were it dependent upon a single recessive gene substitution, we should expect to find a large incidence of cousin marriages among the parents of the patients. This is not true of the retinoblastoma cases. It was true in the series of xeroderma pigmentosum pa-

tients, where we found a minimal incidence of 21.2 per cent of cousin marriages, as contrasted with an incidence of 0.2 per cent estimated to be that of the general population.[9] This absence of cousin marriages among the parents of patients with a very rare disease is corroborative evidence that the disease is not dependent upon a recessive factor.

How then can we explain the facts concerning retinoblastoma? If retinoblastoma were due to a dominant mutation it would explain many of the facts in connection with this disease. First, it would explain the scarcity of cousin marriages among the parents of these patients. Consanguineous matings do not increase the liability to the production of dominant characters. Secondly, it would explain the much too large incidence of direct transmission from parent to child. If the disease were due to recessive factors it would be most unusual to have such a large number of affected persons selecting a mate who was unrelated but who carried the same recessive factor. The chance of finding so many matings of this variety was calculated earlier in the paper, and found to be much too low for the incidence of such matings found in the population. But if the disease were due to a dominant mutation, then when a germ cell of a parent had altered to produce such a defect in one of his offspring, such a child, if he or she survived the disease, and reproduced was liable to pass on the affected chromosome to half its offspring. Thus one may have records of one person only in the first generation affected, and transmitting the defect to the second and third generations as a dominant character.

There remain some records, however, which are difficult of interpretation upon the assumption that the condition is dependent upon a dominant mutation. There are a fairly large number of records in which both parents were unaffected, in which they were not related and in which several, sometimes as many as eight, children are affected. Are we to assume that the mutation kept recurring over and over again in the germ cells of the parents? Are we to assume that in these families the mode of transmission is according to the rule of recessiveness, in contrast to the other families in which it occurs first only in one child, and then recurs from generation to generation? Or is the explanation that there was a dominant mutation in the germ cells of a person, but that its effect was prevented from becoming evident because of some modifying factors, perhaps inhibitors; which latter factors were not always transmitted along with the defective chromosome to the next generation? Or finally might it be that the mutation occurred in an embryo in the primordial cell from which all sex cells were later to be differentiated, but at a time after the retinal cells of the embryo were differentiated? Thus one mutation might explain the occurrence of segregation of the defect in the offspring of said embryo when it had grown to maturity, as well as its own lack of the defect itself. Whatever the explanation be, it is evident (1) that retinoblastoma has a germinal basis because of its occurrence in both of identical twins, and in many members of a family, when it is so rare in the population, and (2) that its mode of transmission is not identical with that of xeroderma pigmentosum.

Other examples of the inadequacy of one explanation for the mode of inheritance of all tumors in man are as follows. It is quite common to find families in which several members are affected with gastric or rectal, mammary or uterine cancer. If all tumors followed the same line of transmission, one should be able to find as high a proportion of familial incidences in cases of laryngeal cancer, for example, as of gastric cancer. The total number would be less in the former, because it is a less common type of tumor, but the ratio of familial to apparently sporadic incidence should be the same in both. It apparently is not, and thus indicates either that the two tumors have a different genetic basis, or that one is much more dependent upon extrinsic factors than is the other.

Another observation is that the same clinical type of tumor may have a differ-

ent genetic basis in different families. In Warthin's famous family *G*, the line of descent of both intestinal and uterine cancer appeared for the most part very direct. In many other families, the tumors cannot be traced from parent to child with such unfailing regularity. One of the reasons for this apparent discrepancy may be the early age of onset in Warthin's family, another may be that the transmission of uterine and gastric cancer may not always be the same.

Summary

Not all types of tumors which have a genetic basis have the same genetic basis.

Two tumors are analyzed, one, xeroderma pigmentosum, which has been shown before to behave as if dependent upon recessive factors, inasmuch as it appears in children whose parents were normal and who were related in many cases; and because it appears in about the number of children which one would expect to be affected upon the hypothesis that it was due to a recessive factor; the other, retinoblastoma which does not behave as if dependent upon recessive factors, but as if due to a dominant mutation for the most part. Attempts to find an identical genetic basis for all tumors will probably be futile, as there is no more likelihood of all tumors being dependent upon the same genetic foundation than there is of all eye defects, for example, being inherited in the same way.

Each type of tumor will have to be analyzed as a separate entity, and the relative effects of extrinsic and intrinsic factors estimated if possible. Moreover, the probability that even the same type of tumor in the same organ may have a different genetic basis in different families will have to be borne in mind.

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Making Figures Tell the Truth

(*Continued from page* 395)

be that the alternative methods of rearing the chicks have produced no difference in their rate of growth." As a matter of fact the difference actually found was 1.92 times its standard deviation as estimated by the method used in that paragraph, instead of being zero as the lay reader might infer from the sentence quoted. Indeed the author proceeds immediately with this very same example to show that the conclusion just quoted is false! By pairing full sibs and applying "Student's method" this same difference becomes 2.857 times its revised standard error and therefore "significant." Logically a statistical analysis of an experiment can lead to one of three answers: (1) a significant difference may be found; (2) a difference may be found that is too small or has too large a standard error to be significant by conventional standards, or (3) the difference may actually be zero. Failure to distinguish between (2) and (3) in interpreting non-significant differences may be very confusing to a public not familiar with the nature of experimental proof. The unwary reader may infer that the research worker who has found a non-significant difference has proved that there is no difference.

The biologist who wishes an introduction to statistical procedures, especially those used in field crops and horticulture, or who has been doing only a limited amount of statistical work, should find this book of value.

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POPULATION POLICY FOR THE UNITED STATES

P. K. WHELPTON
Central Statistical Board

IT is becoming popular in the United States as in certain other parts of the world to talk about population policy. Several countries in Europe—notably Germany and Italy—have been giving much attention to increasing the number and improving the quality of their inhabitants. They have put into effect specific measures intended to stimulate marriage, lessen contraceptive practices, banish abortion, and encourage larger families among most of their people. Applying to a small minority held biologically undesirable, however, are other measures which forbid marriage and prevent childbearing by sterilization. Other countries—for example France, Belgium, and Sweden—have taken various steps toward the same or related goals. The question may well be asked: Has the United States reached a similar situation? Should we, too, be developing a program to stimulate growth from most groups of the population and give us larger and larger numbers of better people? To answer these questions intelligently requires some consideration first of what our future increase is likely to be and from what classes of the population it is likely to come in the absence of concerted attempts at control; second, of the relationship between our national resources, the size of our population, and our level of living; and third, of whether there are advantages inherent in a growing population which may overbalance any disadvantages of a rising ratio of population to resources.

The rapid rate of population growth during most of the decades since the Declaration of Independence is too well known to need emphasis here. Suffice it to say that the population doubled from 1790 to 1815, doubled again from 1815 to 1840, doubled a third time from 1840 to 1865, and doubled a fourth time from 1865 to 1900. Had this rate of growth continued, we would now have over 150,000,000 inhabitants instead of about 131,000,000 and by the end of the century our 600,000,000 people would greatly outnumber the Chinese. Ultra-boosters may feel that this in itself is a goal worth striving for!

Although there was no national population policy as such during these past decades of rapid increase, certain parts of our Federal program definitely encouraged growth. Not only were our doors opened wide to immigrants from almost every country in the world, but the advantages of living in this free and enterprising nation were proclaimed to the world by such diverse people as friends of oppressed groups, employers wanting cheap labor, and agents of steamship companies seeking traffic. Once arrived, the newcomers found our public domain placed almost as freely at their disposal as that of our native citizens: For example, foreigners as well as natives could obtain a farm by homesteading. Nor were national policies favorable to growth limited to immigration; the Comstock law was interpreted to include contraceptive materials and appliances, while various State laws prescribed abortion. To the extent that attempts to enforce these laws were successful, the birth rate and population growth from natural increase were higher than they otherwise would have been.

Changing Outlooks

Since the World War, however, our policy toward immigration has changed radically. The discovery that the Americanization of pre-war immigrants had not gone on as rapidly as popularly supposed, plus the realization that millions of persons wanted to leave war-torn Europe, contributed to the passing of the quota laws in the 1920's. Early

in the 1930's the unemployment problem led to even more rigorous control through the "public charge" regulation, which denied admission to newcomers unless their support was guaranteed by their own wealth or by responsible persons already here. As a result, the immigration stream is now a mere trickle instead of a rushing torrent and, judging from the present temper of the nation, will remain so for some years to come. Not until conditions change greatly will we again allow large numbers of foreigners to cross our borders annually.

At the same time, an extremely significant change from the standpoint of population growth has occurred in the public attitude toward contraception. This is not to say that contraceptive methods have only recently been used in the United States. On the contrary, most students of population believe that birth rates in rural areas were half again as high as in urban areas as far back as 1820 chiefly because some type of contraception was practiced by a larger proportion of urban families than rural families. Similarly, these scientists believe that our birth rate was cut in half from 1800 to 1890 primarily because birth control in some form became more widely practiced. Until recently, however, there was little relation between the attitude of individuals toward spacing their own children and their attitude toward birth control clinics and the intelligent public discussion of contraceptive problems. Compare, for example, the persecution of Margaret Sanger and her associates in their first clinic during 1916 with the general tolerance toward clinics at the present time in most states. And try to imagine Mr. Pringle's article "What do the Women of America Think about Birth Control?" being published by the *Ladies' Home Journal* in 1900 instead of 1938!

Looking ahead, it seems likely that information regarding some means of spacing births will continue to spread through the population, gradually reaching the groups not yet informed. It may be expected to bring about a decrease in the birth rate among the lower socio-economic groups in urban centers and among rural people in general, especially those less affected at present by city influences. In contrast, little change in birth rates may occur among the groups which have gone farther in cultural assimilation of contraception and in the stabilization of fertility. To be explicit, the rapid decline in birth rates among southern whites and Negroes during recent years may be expected to continue, especially in the open country, while the fertility of the native white population of New England may remain at the level it has held since 1910.

A further decrease in the death rate can offset part of the decrease in the birth rate, of course, but only a small part. Medical and public health authorities realize it will be extremely difficult to increase the expectation of life of our white people from 63.3 years, the present figure, to 70 years by the end of the century. Such a gain will be wiped out by a 10 per cent decline in the birth rate, which can easily come about—witness the decline of over 20 per cent from 1920 to 1930.

In the absence of effective changes in population policy, therefore, a continued slowing up of population growth may be expected. My colleague, Dr. Warren S. Thompson of the Scripps Foundation, and I have computed the future course of population growth with various trends of immigration, fertility, and mortality. According to our medium assumptions for future trends—no immigration, an increase in expectation of life of white persons to 70 years in 1980, and a decline in the average number of children in a completed native white family from 2.2 in 1930-34 to 1.9 in 1980—the population will increase from the present 131,000,000 to a maximum of nearly 154,000,000 in 1985 or thereabout, after which it will begin to decline. If the average number of children per native white woman declines from 2.2 to 1.5 (our low fertility assumption), a maximum population of not quite 140,000,000 will be reached

about 20 years from now, and by the end of the century our numbers will be little, if any, greater than in 1920. Even if present birth rates should be maintained, which seems extremely unlikely in view of past trends, the population peak would be reached during the next century. It is clear, therefore, that unless there is a marked change in population policy, and unless the new policy is effective, our population will slowly reach an upper limit during the next 20 to 60 years and then begin to decline.

Optimum Population

The official attitude in most European countries is that a larger population is needed. Faced with the probability of a maximum number of people a few years hence, should we, too, adopt measures designed to achieve greater size? Let us consider first the relation between the size of our population, our resources and our level of living. More specifically, is a larger or smaller ratio of people to resources more desirable from the standpoint of the welfare of our population?

If this nation could choose between having a stationary population of 131,000,000 (our present size) or 150,000,000 or 100,000,000, it can be shown quite conclusively that the smaller number would be best from an economic standpoint. The supporting argument involves some economic theory with which I will not bore you. Simply stated, the essential point is that the larger the population the larger the amount of farm land, mineral deposits, and other natural resources which must be used, or the more intensively a given amount must be worked to provide the basic necessities of life. Since our farm lands and mineral deposits vary in quality and accessibility, working a larger quantity of them will necessitate working poorer grades. Both this expansion and an intensification of methods tend to reduce the average production per worker, which in turn tends to lower wages in these industries or raise the prices of their products. Either will lower the living levels of the population.

From the standpoint of the efficiency of workers in manufacturing and trade, it matters little whether our population amounts to 100,000,000 or 150,000,000. In either case the number of people to provide for is so great that innumerable factories and stores are needed. The essential difference under the two conditions is in the number of factories and stores, not in their human efficiency.

In transportation and communication an important part of the cost of service rendered is the construction of the highway, railroad, or telephone line. Once these are built, the number of people and tons of freight transported and the number of messages sent can increase greatly with little increase in the annual cost for upkeep or replacement. A population considerably larger than that of today, therefore, should be beneficial to output per worker in these industries, and hence to the general standard of living.

Summing up, a population of 100,000,000 as compared with 150,000,000 in the United States should have a higher output per worker in agriculture, forestry, and mining, about the same output in manufacturing and trade, and a lower output in communication and transportation. Considering the fact that in 1930 agriculture and mining employed about three times as many workers as transportation and communication and supported a still larger proportion of persons, the net advantage lies clearly on the side of a smaller population than the present, rather than a larger population. The United States is *now* overpopulated from the standpoint of per capita economic welfare, but fortunately not as seriously overpopulated as most nations.

You will notice I have not referred to the 12,000,000 persons now unemployed as evidence that our present ratio of population to resources is too high. My belief is that the present high unemployment is connected very remotely, if at all, with our overpopulation. There seems to be plenty of evidence that the main reason why so many people lack jobs is the failure of our economic system to function

smoothly, which in turn results from our failure to develop an adequate mechanism for controlling it.

Growth *vs* Decline

To talk about the advantages and disadvantages of a population of 100,000,000 compared with one of 150,000,000 is one thing; to talk about those of a growing compared with a decreasing population is another. Although a lower ratio of population to resources favors a more comfortable level of living than does the present ratio, it may be that this is more than offset by disadvantages associated in some degree with a slowing up of population growth and in a greater degree with a decrease in numbers.

No one denies that a rapid growth in population and a substantial improvement in living conditions have gone on together for a century or more in most western nations. It is not so clear, however, that the people in the nations with the most rapid increase have had the largest gains in living levels; on the contrary, in some of the slower growing nations the change has been equally favorable. Nor does the fact that living conditions improved during a period when population was growing prove that the latter was an important cause. In the light of the evidence available, it is much more reasonable to conclude that both have resulted from a common set of causal factors, among which scientific discoveries and inventions are of extreme importance.

Nevertheless, certain advantages of a growing population have been advanced by various persons and merit attention in considering the aims of a population policy. For one thing it is said that rapid growth helps to minimize the harm done by overexpansion of facilities in various lines. If factory capacity is increased too rapidly, if real estate developments take place on too large a scale, it will be possible to market the factory products and rent or sell the homes or offices in a shorter period if the population increases rapidly than if it increases slowly. But the other side of the picture should not be overlooked—if these developments go on in some period at too slow a pace, the seriousness of the situation is increased by a rapid population growth. It seems to me, however, that the proper solution for problems of this type is not the stimulation of population growth, but more intelligent planning on the part of private and public agencies.

Another advantage claimed for an increasing population is its higher proportion of young people in the working ages. Youth is supposed to represent progress, the development and adoption of new manufacturing processes and business methods which increase human efficiency. A rapidly expanding population is believed to offer them more opportunity to forge ahead, achieve positions of control, and put their ideas into practice. In a stationary population, in contrast, elders constitute a larger proportion of workers; they are likely to fill relatively more of the dominant places, and being more cautious and conservative, to retard the rate of change. The force of this argument depends in part on the extent to which change is progress, and in part on whether or not soundness of judgment increases with age and offsets any loss in the willingness to experiment and take chances. Opinions will differ on these matters, though perhaps the preponderance will be in favor of youth.

As far as the ratio of workers to dependents is concerned, there may be little choice between a rapidly growing population and one which is stationary. The former will have many children to raise but few old people to support; the latter will use more of its budget for elders and less for children, but may live equally well.

Economics of Expansion and Stabilization

In recent months much has been said about another advantage of a growing population. The logic runs somewhat as follows: Prosperity — that is, high per capita income — depends on full employment in the producers goods in-

dustries, which depends on a large flow of capital into long-time investments, which in turn depends on the development of new industries or on an increase in population. It may be true that in the past per capita income has varied from year to year with the amount of long-time investment and the increase in people, but let us examine the broader implications of this theory. By and large, the productive effort of a nation can be utilized to provide goods and services for current consumption or to develop facilities for greater production in the future. The more rapidly a population is increasing, the larger the share of its productive effort which should be directed toward expanding capacity for the future, and the smaller the share left to produce for present day needs. A stationary population thus has the advantage over a growing population that it can put more emphasis on producing for itself and less on producing for the future, which should mean more consumption goods per capita and higher living standards. The important thing in either case is that the working force be fully employed. This need not be left to depend on population growth; it should be susceptible of direct influence if the emphasis laid on improving our social and economic knowledge and practice is more nearly commensurate with that heretofore placed on the so-called physical sciences.

I hope what I have been saying has not given you the impression that I believe our standard of living will fall in the future with the population growth which I anticipate will occur. On the contrary, I believe our standard of living will rise. My argument has been that our people will live better not *because* they become somewhat more numerous, but *in spite of it*. The improvement will be caused primarily by an increase in our technical knowledge in such fields as production, business management, and government and in our ability to put this knowledge into practice. I have tried to make it clear that an increase of population helps to give a high level of living only when a nation is underpopulated judging from the ratio of people to resources, or when it is somewhat overpopulated but does not know how to regulate its economic life. The United States is now somewhat overpopulated, but in my opinion it need not remain indefinitely in its present ignorance about economic controls. Since our economic education may proceed slowly, however, it may be well to adopt a population policy which will retard somewhat the slowing up of growth. This will prolong the period during which increasing numbers may help our economic system and provide time for the development of more direct controls.

Most of my talk so far has been devoted to the quantitative goals of a population policy because it seems to me that even an intelligent group like this is heavily influenced by the general but uncritical acceptance of a large and increasing population as the ideal. I cannot hope that many of you who are "big population" people have changed your minds already, but I do hope your future thinking will lead you to change.

What to Do

As far as the qualitative goal of a population policy is concerned, it seems to me there is general agreement that we want a better population, and that improvement should be sought as rapidly as is feasible.

Accepting as the goals of population policy the prevention of too rapid slowing up of growth and the improvement of the quality of the population, we face the knotty problem of determining the specific measures which should be adopted. Manifestly we could add large numbers of people in a short time by again opening our doors to foreign immigration. While our moral or spiritual duty may be to do this, a majority of even the "big population" advocates do not appear to favor such action. Apparently it is generally agreed that under present conditions, the only people who should be admitted in large numbers are those who are sufficiently rich to live without working. Only they will swell the number of consumers

without increasing the competition for jobs or becoming dependent on workers or relief agencies. In addition, there is the remembrance of the problems of assimilation and Americanization which arose after a period of rapid immigration in the past. As far as our immigration policy is concerned, it may well be that only minor changes, such as admitting refugee children, should be sought for some years to come.

If relaxing the immigration restrictions is ruled out as the way to check the slowing up of population growth, attention must be turned to measures affecting the birth rate. The first suggestion from some quarters would be the prevention of abortion, the banning of dissemination of information regarding contraception, and of the manufacture and distribution of the materials or appliances used for this purpose. By controlling the severity of the preventive measures it should be possible to check the decline of the birth rate and even bring about a significant rise, thus achieving the ends desired from a quantitative standpoint. Qualitatively, however, such measures would do much more harm than good, for it would be most difficult to affect the more able, intelligent and farsighted portion of the population. Such persons would be able to continue to limit the size of their families in the future much as they have in the past, hence the additional children would come chiefly from the other groups. Clearly the qualitative need is for measures in the opposite direction. Instead of curtailing contraception there should be a rapid increase in facilities for giving sound contraceptive advice to those groups which have not yet been able to obtain it. In addition, the materials and supplies should be provided free when necessary, so that poverty alone could no longer prevent the spacing of children. Manifestly such a task is too costl yto be undertaken by private or philanthropic agencies; it must be a function of Government.

There is no question but that a system of publicly supported birth control clinics adequate to help in improving the quality of our population would also tend to speed up the cessation of growth and the beginning of a decrease in numbers. To prevent this from going on too rapidly, I believe we need measures akin to those being tested in Sweden, a democracy faced with similar problems. There the endeavor is to lessen the cost of children to the parents rather than to pay money to people for having large families, as in Germany. Although this may sound like two ways of saying the same thing, there is a fundamental psychological difference in the procedures. Money paid directly to parents can be used in a wide variety of ways, many of which may not be desirable from the standpoint of the children, the parents, nor society in general. In contrast, such things as rent subsidies for families with two or more children, free medical care for mothers during pregnancy and for children until working age, and public creches or kindergartens to relieve mothers of part of the care and confinement of raising children would appeal equally well (if not better) to couples wanting children for their own sake and not for their money value. Since there is plenty of evidence that the cost of raising children and the load they place on the mother's time and energy play an important rôle in limiting the size of families, it is reasonable to expect that family assistance of the type outlined could go far toward checking the decline in the birth rate. Conducted on an adequate scale, it could even bring about some increase, even if birth control information were made generally available.

It may be argued that it will cost too much to maintain the clinics, housing projects, health subsidies, creches, etc., suggested above. That they would be expensive is admitted. But that such a program would be a worthwhile national investment is, I think, susceptible of proof. Certainly we can afford to lay out large sums in ways which will gradually improve the quality of our population and forestall too rapid a shift from population growth to population decline.

RECREATION AND EUGENICS

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WHAT contribution does or can recreation make to modern eugenics? Recreation as used here refers to facilities and services provided for the public at large and principally by governmental agencies. There is a vast amount of other recreation available to individuals from commercial and private sources. There are also the extensive unrecorded hobbies and informal leisure interests of individuals and families. All these differ from public recreation in that they serve selected portions of society, reaching special age groups, one sex or the other, one religious sect or another, groups with special capacity to pay for service, or other particular categories. Public recreation, on the contrary, is addressed to all age, religious, racial, economic, and social groups although different communities vary in the emphasis on groups which are served.

The resources of public recreation are now very extensive. Among them are the national and state parks and forests, county areas, and municipal parks, playfields, and playgrounds. There are such common facilities as camps, pjcnic grounds, trails, nature museums, beaches, golf courses, lakes, tennis and numerous other game courts, swimming pools, children's play apparatus, etc., not to mention many assets for relaxation and aesthetic enjoyment. Also available to the public are thousands of recreation buildings and other indoor centers in which sports, social occasions, drama, music, crafts, classes, discussions, and other activities are conducted. In addition to operating these facilities, public agencies promote family and home recreation activities and conduct training courses for volunteer leaders and civic celebrations. They assist agencies and groups in conducting picnics, parties, and festivals, instruct individuals who want to develop recreational skills, organize many groups for activities, provide naturalists, guides, and maintain an information program about recreation.

Direct personal experience in some rewarding activity as opposed to vicarious enjoyment as a listener or spectator is the principal emphasis in public recreation. Its activities are simple, unsophisticated, and racially old. Its outdoor phase is associated with open spaces, woods, and natural elements. It fosters the "primal sanities" of which Walt Whitman writes. Most of the program is for groups, typical of which are the team, the class, camp unit, the orchestra, drama group, and the club, all of which make for social experience. Public recreation numbers is participants by the millions, many of whom take part with regularity.

Aims of Eugenics

Over against this brief review of public recreation, are two fundamental objectives of eugenics, namely, first the removal of economic handicaps so that husbands and wives may feel free to have children; second, the development of motivations and desires that will induce economically unhandicapped couples whose hereditary capacities for usefulness are above the average to have children and rear them wisely. The first objective implies measures that are preliminary to the eugenic program proper. The second calls for measures which are directly eugenic.*

In what respect does recreation affect these twofold objectives of eugenics?

A. Recreation and the Removal of Economic Handicaps

On the first or preliminary level recreation along with public education, improved housing, and other social measures is providing free or inexpensive interests and activities which are a neces-

*See "American Eugenics Today," American Eugenics Society, 50 West 50th Street, New York, N. Y., January, 1939.

sary part of decent living, personality development, and citizenship training. The cost of these activities is born collectively through taxation. The burden on any individual is slight, yet the same opportunities bought individually would often be prohibitive in cost.

The growth of free public recreation has been extensive during the past generation. In city slum areas as well as in smart suburban towns are neighborhood playgrounds, parks, tennis courts, swimming pools, and community centers where recreation may be had either at no cost or for nominal charges. Even golf is available in many communities at very moderate fees. Activities which thirty-five years ago were within the reach of a select few are now open to millions. The process of socializing the nation's resources for recreation has developed swiftly in the last twenty years, especially under the acceleration provided by Federal policies during the depression. National and state parks have expanded, municipal parks have been improved, thousands of tennis courts, swimming pools, and other facilities have been constructed. Lake and river frontage has been recovered for the people by public action and has been utilized for recreational purposes. Camp and picnic areas have multiplied. Though less pronounced, there have also been substantial gains in the utilization of public school buildings for recreation.

It is true that these opportunities are still not available to millions of Americans. Yet, in numerous communities, young couples can find near at home a well rounded recreation program at slight cost. Figured in the dollars and cents that would be required if these things were bought from commercial agencies they *can* save substantial sums toward the cost of rearing children.

Competition of Commercialized Recreation

This development has not counted as heavily as it might have because of the counter-growth of commercially promoted recreation and amusement. This enormous development has been advanced by a terrific volume of pervasive and exciting advertising, creating new recreational wants and involving much personal expenditure. Hence the "standard of living" as to recreation has stepped up along with the standards for food, clothing, and shelter. Many young couples think they must start off marriage with an automobile. The movies and travel are other pleasures which have a powerful lure. Consequently many are not content with the simple, inexpensive recreations available to them.

Whatever the future of commercial recreation, we may expect that public recreation will continue to expand and will probably increase its relative contribution to keeping down the cost of living by supplying cheap opportunities in leisure.* It is becoming more diversified and it caters more and more to young people 16 to 25 who are in the "dating and mating" ages, and to those over 25. Certainly it is already a major resource of that part of the population whose incomes are marginal.

B. Relation to Direct Eugenic Measures

What is there in the recreation program which tends to influence the values associated with family life and to create a love for children? We submit that there are no statistics which record the numbers of superior parents who, because of the Cincinnati Recreation Commission or the New York City Park Department, have been induced to have three or four children! However, a considerable part of the public recreation program is clearly family activity.

This family aspect is obviously true of much of the camping in the Federal and state parks. Such camping at Adirondack sites in New York State may be cited as an example. There are some 500,000 different campers at such sites each year, predominantly in family groups.

Picnicking is similarly a family activi-

*See "Economics of Recreation," Julius Weinberger, Harvard Business Review, Summer, 1937.

ty. It has developed rapidly in recent years stimulated by the automobile and the great increase in picnic areas. In 526 cities 619,000 individual picnickers were reported by municipal recreation departments in 193. In 199 of these cities the total participation, including repeaters, at 1,438 areas was reported to be 12,369,000. Obviously these totals represent only a part of the actual picnicking in the country last year.

At the nearly 10,000 neighborhood playgrounds in urban communities numerous events were held periodically which brought together whole families, although most of the services at playgrounds are for children five to fifteen years of age. These events are often called "community nights." The municipal recreation departments in common with private non-profit agencies conduct other activities intended to bring parents and children together and enhance family feeling. Included are Mother's Day, Father's Day, Mother-Daughter, Dad-Lad, Daughter-Dad, parties, banquets, and outings and even family reunions. An important variation of such events is the folk dance festival, folk art exhibition, etc., in which the American-born children of foreign-born parents see them portray some of the culture of the old country before the admiring eyes of American audiences. Such folk events increase the respect of children for their parents and strengthen family bonds.

Recreation for the Family at Home

Contributing directly to the enhancement of family life are the educational activities and services given in promoting family play at the home. This is done by many though scarcely by a majority of municipal recreation departments. They distribute literature explaining how to construct backyard playgrounds, homemade apparatus, fireplaces, and other equipment; provide lists of games, musical, dramatic, and other activities suitable for the home with instructions on how to develop them; publish newspaper articles, and give series of radio talks advising parents on home play. Some cities have held contests to stimulate the development of backyard playgrounds and family night programs. In one city an empty house was taken in a crowded area, furnished in the prevailing neighborhood style and kept open for recreation with a demonstrator in charge. Home orchestras have been fostered leading in some instances to neighborhood orchestras made up of several families. Discussing this subject at the Twenty-Third National Recreation Congress in 1938 a group concluded that among other things families must learn how to budget their time as well as their money for recreation.*

Direct promotion of family play at home operates selectively in that it is most feasible among families that live in sizable houses with yards, recreation rooms, and other facilities. People in small apartments and tenements have little elbow room for such purposes. This shortcoming is being increasingly relieved by the tendency to include recreation or rumpus rooms even in small houses and to construct both outdoor areas and indoor facilities in multiple housing developments. In any case, most dwellings, however cramped, have dining rooms which may be the center of much recreation. One writer suggests that it would be better to convert the dining room into a recreation room and have the family eat off trays in front of the fireplace or elsewhere!

Other Interests

Besides what has been mentioned, there are other activities in which families or parts of families share. One is golf; others are archery, tennis, swimming, croquet, bowling, orchestras, dramatics, and choruses. There is a growing tendency among recreation departments to emphasize recreations of lifelong value as against the strenuous sports which must be given up early in life. This creates more opportunities in which families may participate as groups.

The great increase in community activities has led to the criticism that people are being drawn out of the home and

*Proceedings of the 1938 Recreation Congress, National Recreation Association, 1938.

that the family is disrupted. There is some truth in the criticism. On the other hand, rich outside experiences of the several members of the family which develop their personalities may in turn stimulate other members of the family circle. It is not only what develops within the family but what is brought to it from outside that contributes to successful family life.

The emphasis given above to recreation for the family unit is based on the conviction that companionship and playfellowship are family assets that should be strengthened because they create and conserve family ideals. I am aware of the viewpoint expressed in the flippant "I cannot do anything about my relatives but thank God I can pick my friends," but I do not share it. I believe in grandmothers, grandfathers, uncles, and aunts, young parents, and a varied assortment of grandchildren — and, in family reunions.

Co-Recreation

Another contribution of organized recreation to harmonious and stable family life is the current encouragement of co-recreation. Many interests, including games of the social type, swimming, dancing, hiking, discussions, music, drama, and crafts are now developed for mixed groups of young people of both sexes. A value of this shared participation, particularly when it involves cooperation and sharing of responsibility, the give and take of competition, and the testing of courage, patience, modesty, and persistence, is that girls and boys are revealed to each other for what they really are and sometimes in trying situations. Out of these wholesome relationships which contrast sharply with the artificial and shallow relationships in many amusements come marriages of persons having significant leisure interests in common, and clear understanding of their respective personalities. Married couples who established such interests and understandings before marriage are not so likely to find their way to the divorce court. And harmonious marriages are likely to result in children.

Rural Scene

Turning from the urban to the rural setting, we find an environment which is naturally conducive to many of the types of recreation which produce durable satisfactions. However, it is noteworthy that the country community is less developed than the urban in respect to social recreation interests for young people 16 to 25 years old, the age period when decisions as to migrations from country to city are likely to be made. Although the economic factor and the lure of the city's bright lights count heavily in motivating young people to leave the country, it is plausible that adequate and attractive rural opportunities for recreation and social life will help to check the flow of rural youth to the cities and help to stabilize rural family relationships.

Much is now being done to train volunteer rural leaders in recreational methods by the National Recreation Association, universities, and the government. It may be expected that gradually rural opportunities for social recreation at all age levels will help to counteract the forces that draw young people from the farms and villages where ordinarily families are larger than in the cities.

General Effect of Recreation on Ideals

Recreation instills a sense of the life-values of cultural and recreational skills, in contrast with concentration on acquiring material wealth. This has its bearing on the readiness of people to subordinate possession to expressive living and should put a higher value on family life. The American people have always been accused of being materialistic but the present enormous expenditure of a nation under reduced circumstances for recreational activities suggests that their ideals are changing. From a combination of causes there is apparently less disposition to plan life around the idea of making as much money as possible and perhaps spending it lavishly, and more disposition to get as much out of life as possible as one goes along from day to day.

Do the Eugenic Influences of Recreation Function Selectively?

It has now been shown that public recreation contributes definitely to eugenic objectives on two levels; (a) by helping to reduce the cost of recreation, thus freeing funds for the rearing of children and (b) fostering family life and educating for stable and harmonious marriage. Also, the point has been stressed that public recreation is inclusive, serving all groups and levels of society. It is a cardinal principle that a public service shall be available to all.

If anything, in practice in most communities the first concern of the recreation leader is for those groups and neighborhoods who have the least advantages. Furthermore, the unskilled, whether in social relationships, games, appreciation of nature, music, or other interests, are usually the first concern of public recreation. In this respect it is unselective.

However, along with the principle of inclusiveness and democracy is the principle that the satisfactions of recreation grow with skill. The recreation leader undertakes to provide the instruction and facilities that will encourage progress in achievement. People differ widely in their capacity for such growth. Some recreation departments cater rather too much to the last group, particularly in sports. The individuals who are most highly skilled are usually those who have a combination of all or some of the following qualities: strong physique, good health, good intelligence, superior capacity to get on with others, and balanced personality. Only in the above sense does the recreation service function selectively.

Some of these superior recreationists remain relatively untouched by those influences of the recreation program that directly encourage family values. This is because their activities are limited to one or two interests, or to association only with their own sex or are otherwise narrow. Others are frequently exposed to family values.

Future Emphases in Recreation

As to the direction recreation should take if it is to extend its eugenic influences, these suggestions may be made.

1. There should be more direct promotion of family recreation both at home and elsewhere. Nor should the mistake be made in this mobile age of identifying the house and yard with the family. Many family values can be conserved and developed away from the home itself.
2. More emphasis on family interests should be developed at public centers. The Jewish community centers probably lead the way in this as they stress family participation.
3. More co-recreation should be developed for young people, particularly those interests involving "work" experience, the carrying of responsibility, discussions on topics that matter and the testing of fundamental personal qualities. Mixed activities should be fostered in pre-adolescent as well as adolescent years.
4. More generalized recreational experience should be encouraged so that, for example, good swimmers may also become good picnickers, et cetera. Young people's clubs that undertake varied interests are desirable.
5. The extension of neighborhood facilities and services is one of the imperatives, especially in the disadvantaged parts of industrial communities. The need of year-round social opportunities for young people is especially great.
6. The upbuilding of family life is an appropriate topic of discussion among young people's and adults' clubs, discussion groups, and forums.
7. Finally, there is the influence of the recreation leader as he goes about his daily work. The leader can influence young people powerfully with reference to family loyalties and values just as he is expected to do with regard to personal behavior.

If this analysis of the relationship of recreation to eugenics is sound, the eugenist has an important stake in the steady expansion of public recreation.

AN UNDERGRADUATE VIEWS EUGENICS

Prize Essay in a Contest Conducted by the American Eugenics Society

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THE reader may recall the substance of an advertisement used by a well-known publishing company some months ago. It was a story that went something like this:

Two young city women on a vacation thought it would be good fun to see a County Fair. They wandered over the fair grounds on a warm September afternoon, looked with incurious eyes at displays of prize pumpkins, cakes and canned fruit, handiwork and husbandry. At two o'clock a bugle sounded. A young chap in overalls shouted, "Come on, Joe! They're going to judge the dairy cows now." The crowd moved forward to the pretentious Livestock Pavillion. Swept along with it, the two city women moved toward the huge tanbark arena, saw the decorous rows of placid cows, watched the earnest judges at work, marveled at the attention of the crowd. A pair of judges checked heights, girths, coats, scrutinized udders, heads, horns, hooves. Squatting at points of vantage, they took careful note of conformation, and after serious conference, the judges awarded the prized blue ribbon to a sleek fawn-colored Jersey, proud heiress of a century of better breeding.

Impressed, the city women followed the crowd into the adjoining tent where a baby show was under way. A harried minister and two flurried matrons solemnly surveyed rows of tired, cross and overdressed babies squirming in the laps of proud mothers. And after much covert whispering, minister and matrons awarded the blue ribbon to a large placid child, resplendent with gold curls and a pink lace bonnet. One of the city women gasped. She was a trained nurse, and the vacant blue eyes of the prize-winning baby told her that here was a sub-normal child. The young nurse couldn't contain herself. "My God!" she said, "They know more about cows than they do about babies. Something ought to be done about it."

When one comes to know for the first time the potentialities of the eugenics movement and appreciates how much there remains to be accomplished before its objectives can be realized, he, too, is apt to exclaim: "But why hasn't more been done about it!"

This, indeed, was the writer's earliest criticism of the general program of "practical" eugenics. Why hadn't it been practiced? If California and many other states are satisfied with the results of eugenic sterilization, why hasn't the plan been advanced in all States? The trend of the race toward degeneracy has its basis in facts. We know what need be done to correct the differential birth rate, yet permit the factors which make for this decadence to remain in operation. In short, why hasn't somebody "done something about it?"

This fanaticism was short lived. A little more information and sober reflection made the answer all too apparent. The problem is much too big to expect an overnight solution. For many years now, science has busied itself with the building of a brave new mechanical world, without giving a thought to the biological quality of the men who inherit it. Only recently has there come the realization that while the environment has been made better, the calibre of the men who fill that environment has certainly not improved. It is time then to turn our efforts to the building of better human beings. The science of eugenics offers the means for this biological renovation. Nothing is to be gained, however, by deluding ourselves as to the amount of work involved. No doctrine will enable man over a period of a few generations to catch up biologically in a

lag which has existed for generations. There are many inhibiting factors to a "rapid salvation" of the race with ramifications into the fields of biology, sociology, and economics, all of which are too complicated to be analyzed in any one paper. If man is to produce a society of human beings worthy of and comparable to the standards of modern mechanical achievement, if eugenic principles are to be respected and practiced universally, the change must come slowly. Eugenics cannot be forced.

The lasting betterment of mankind cannot be reached by short cuts but must come gradually from within. And all efforts must be preceded by education. If eugenics means a replacement of values, voluntary parenthood, and economic redistribution, the individual must be shown why these are good, for with that the battle is more than half won.

This slow and easy method of application takes on a decided significance in view of the methods of the totalitarian dictators to achieve the goals they deem desirable. Dr. Joseph K. Folsom has suggested that under a Facist system it would be possible to create a religion of eugenics. "Since society in that system," he states, "is a concept superior to the individual and to all individuals, duty and identification with the group can be made really effective."

Again, "eugenic advancement" in National Socialistic Germany comes in for more praise by Marie Kopp who is also quoted in the American Eugenics pamphlet of 1938. Now the present writer is not at all reluctant to concede the merits of many principles of the German or other Facist programs, but surely no scientist, nor anyone interested in lasting human progress, can subscribe to even theoretically sound principles when they are administered by unscrupulous barbarians. Here, too, one of the greatest weaknesses of the eugenics program as practiced in Germany stands out in its boldest relief — who is to decide what person or persons are "undesirable" and not fit to give progeny? In a country in which "political" prisoners are given the inhuman treatment afforded in concentration camps, what guarantee has one that "eugenic" measures will not be used in a similar fashion? Further, just exactly what does the Nazi "purification of the German Race" mean? Is this eugenics?

Nor can one believe the dictators have any honest desire for producing biologically greater nations. Such aims would be indeed incongruent. While Il Duce shouts for bigger and better babies, he is not at all disturbed when he gets seventy-five per cent of his increase from those his own newspaper terms "inferior" parents. He demands only that they be able to shoulder a gun. In fact, he prefers they be "inferior" for he knows that intellectuals dislike being used for cannon fodder. Men who think are dangerous. It is better they should not be born. Intellectual deterioration is necessary for the survival of dictatorship. A differential birth rate for the authoritarian state is an insurance policy on the life of the regime.

The survival of democracy, however, depends upon the survival of intelligence. We who cling to democratic ideals are so busy fearing for the safety of democracy that we ignore a similar intellectual decline in our own population. The only difference in these declines is that ours is natural, while that under dictatorship is artificial. In these troubled days democracy is meeting a crucial test. We thought we had found our potential millenium in government, founded on liberty and equality. But now powerful nations are brazenly declaring that democracy is a fool's dream and liberty is a lie. What is to be the answer? Democracy rests upon the axiom that the cooperative action of the entire group is superior to the dictates of the demogogue. The success of this method is dependent upon the relatively high mental calibre of the group members. But each day we witness a decline in the level of intelligence in the population. If such factors as the differential birth rate be permitted to exert their degenerating influence for long, we may well fear for the workability of the method we hold dear. When men are no longer able to think

for themselves, democracy will collapse.

The eugenist's placement of group welfare above that of the individual should not be misconstrued. He does not despair of the ideal of building a government around and for the individual rather than the state, but insists mankind realize that democracy can be no better than the calibre of the individuals who compose the democratic group.

It is here then, it strikes the writer, that eugenics as a movement for bettering human welfare can serve its greatest purpose. Namely, by building a firmer foundation under our democratic structure of government. The question is how this is to be accomplished.

Certainly those who would remold the germ plasm overnight by a process of selection and advantageous nurture had best be reminded there is much to be learned by genetic research before the problem can be tackled so vigorously. Nor does the writer agree with those who hold that the movement needs not so much mere facts, but rather a Messiah, a propagandist, to instill in it some motivation. To clothe eugenics in ballyhoo in an effort to increase its sales value among the masses would only cheapen the movement.

The writer, a Catholic, is a liberal arts student entering medical school next year. It is quite natural then that he is particularly interested in the relation of eugenics to education, medicine, and religion. He would like to consider in this paper the part these agencies can and must play in building a eugenic society.

The avenue by which eugenics will find its greatest progress is, it seems to me, that of our school system. It is gratifying to witness the rapid spread of popularity of instruction in marital relations that is occurring today on the American college campuses. This is, undoubtedly, indicative of a sincere and honest interest on the part of our undergraduate generation to know how they can be good parents. They are asking for a frank and intelligent discussion of problems which a decade or two ago dared not be introduced in the school room. These students are being given the facts eugenists have accumulated for them—these, the mothers and fathers of tomorrow.

A short account of what was accomplished this year at a college in the Middle West may serve to illustrate a trend that is nation-wide. This school, with an enrollment of around four hundred, is a liberal arts college for men. Last fall, the faculty was presented with a petition from the student body requesting that a series of lectures be arranged dealing with the various phases of marriage. The petition was "fostered by a conviction that such a course would contribute materially to the benefits of a liberal arts education and offer excellent opportunity for sane and wholesome instruction in meeting the problems of married life." As a result, there was offered an extra-curricular course of lectures in which sociological, biological, medical, economic, psychological, and religious problems of marriage received careful treatment. Several of the talks were given by guest speakers, men well known in their field, and well qualified to speak on their subject. For several reasons it was thought best to restrict admission to members of the senior class only. Though attendance was purely voluntary, over ninety per cent of the class took advantage of the lectures.

This type of instruction should be carried farther. Appropriate courses should be given in our high schools. Eugenics should be studied along with high school biology, history, and mathematics.

Parallel with this means of education, a second avenue offers itself for the extension of eugenic knowledge. The relation of eugenics to medicine was well handled in a recent report of Dr. Haven Emerson to the American Eugenics Society. In a sense, the physician is morally obligated to correlate his work with that of the eugenist. For he more than anyone else has made possible the survival of the unfit. We have in our humanitarianism "concentrated on nurture and forgotten nature." If truly humanitarian, we must go further than making life enjoyable for the defective—we must remove the cause of his being so. Some-

one has rightly interpreted birth control among the ill-begotten as being nothing more than preventative medicine. The physician is peculiarly well equipped to help make this prevention effective.

In many States the need of some adequate marriage legislation requiring among other things physical fitness as a qualification for receiving a marriage license is generally conceded. Here again the medical profession could, if it only would, be a potent force in arousing state legislatures to action.

It would be putting it mildly to say I am grateful for the perspective the study of eugenics offers. What specific training is to be had along this line in the medical curriculum, I have yet to learn. But limited though my knowledge is, I cannot now conceive of an adequate premedical training which leaves out the study of genetics and eugenics. Yet the majority of students entering medical schools today have no more than an incidental knowledge of the principles and objectives of the eugenics movement.

Perhaps the greatest impediment to many lines of eugenic progress is that ugly bugaboo of public prejudice. In these modern days there are still people who meet any attempt to control scientifically the calibre of tomorrow's generation with a storm of indignant condemnation. Long have they admitted the rôle of heredity in plants and animals. They would never think of breeding into a purebred herd of cows a bull of inferior blood. And yet they deny that man is an animal and subject to the same biological laws. They hang on to the vain hope that man can somehow escape from the laws that govern all living creatures.

Sixty-four years ago Anthony Comstock crystalized this preverted public opinion into a law, making information concerning one item of science a criminal indecency—a taboo in polite society. And today there remains much of this same deplorable attitude on questions of public morals—an attitude which in suppressing authentic birth control information enables the bootleggers to make a seven million dollar a year racket out of the sale of dangerous and inferior devices.

It is in correcting this public attitude that such books as Huntington's *Tomorrow's Children, Sterilization for Human Betterment* by Popenoe and Gosney, and *Science of Human Reproduction* by Parshley are serving their fine purpose. They are very readable books, written in the laymen's language, to inform the layman. Dr. Huntington states the problem: "There is a crying need for eugenic lectures and for the widespread distribution of thoroughly scientific but easily understood discussions on the many phases of eugenics."

It is here also that organized religions could do so much in enlightening some of their more bigoted members — and certainly a great deal is being accomplished. The writer sometimes finds it difficult to endorse the opinions of many of his fellow Catholics on the subject of birth control. Usually these opinions arise not so much from ignorance and prejudice as from a deep-seated conviction that conception should not and must not be controlled by man. It is a matter of religious belief, but a personal one however, since the church as such does not profess the same attitude. The greatest objection of the Catholic Church to the use of birth control, as I understand it, is the fact it tends to foster a laxity of moral conduct — an objection which is not without its justification. Most instruments conceived for human welfare, however, can be an evil if misused. The answer is not to scrap them, but to educate the public that they may be used in the spirit in which they were produced.

Further, even the most orthodox of creeds does change in its interpretation of human values. The Catholic Church of today would be the last to insist that what was right at one period is necessarily right at a later date in the light of new found knowledge. When these controversial aspects of practical eugenics begin to bear fruit, they will find an enthusiastic advocate in Catholicism. Until then, though regrettable, they will continue to be met with apathy.

I am interested in the statement of Dr. Louis I. Dublin who "thinks with all his heart that scientific thought can be integrated with religious thought." Much depends upon what is meant by the word "integrated." If Dr. Dublin merely hopes for a closer association between science and religion, I, too, share his hope. Further, eugenics, an applied science, can do much in bringing about this correlation. But if by "integrated" he anticipates a day when scientific thought and religious thought shall be made one, I do not share his optimism. It seems to me there is an impossible breach between them. They have their only common ground in that both aim at the same or similar goals, but the respective approaches are direct antitheses. One involves an emotional, the other an intellectual treatment. One is deductive, the other based on objectivity. Nor need we be at all disturbed by this inherent gap. Mechanistic views for the purpose of scientific research need not shake an intelligent man's religious views nor dull his appreciation of the aesethetic. They can, in fact, strengthen these emotional conceptions and give him a personal philosophy that is truly balanced and rounded. The old feud of science versus religion arises from misunderstanding and a refusal to see another's view. What we need is understanding among men — not necessarily agreement — a greater perspective of the common goal, and a more compassionate appreciation of the other fellow's method.

In spreading eugenical knowledge by way of these three avenues, the schools, medicine, and the church, I repeat my belief that a purely intellectual approach will be most effective. The subject is not one over which to become fanatically emotionalized. That might do in Germany, but not in America. We are dealing with hard-headed biological facts. Let us have them understood as such. And let us do all we can to spread that understanding as quickly as possible, so that the day will not be long in coming when the nation's social and economic problems will be treated in the light of their eugenic implications, and where the importance of a well-born, well-reared generation will be appreciated by every man.

Today we are appalled to watch European cultures crumble and fall. We find that ideals which we had thought to be firmly entrenched in the hearts of men are now being challenged in many parts of the world. Now, even as I write, men are being driven from their homes, thrown into prison, even killed for daring to believe there exists such a thing as the human right of an individual. Can it be that modern civilization has only produced better means for attaining worse ends?

As the biologist and the social philosopher sit side by side contemplating these alarming tendencies they wonder whether those instruments of science which have charted the heavens, explored the stratosphere, plumbed the sea, and weighed the atom will prove to be the monster which destroys its Frankenstein. They wonder whether our tottering democracy is to meet the fate of other civilizations. I am tired of being told that democracy is worth fighting to preserve. I know that. I want to see it strengthen its defense by building a social order which will give to men the richest environment of which our intelligence is capable, and make us conscious of our responsibility to place in that environment a race inherently well-born—mentally able to accept and execute the responsibilities of democratic government.

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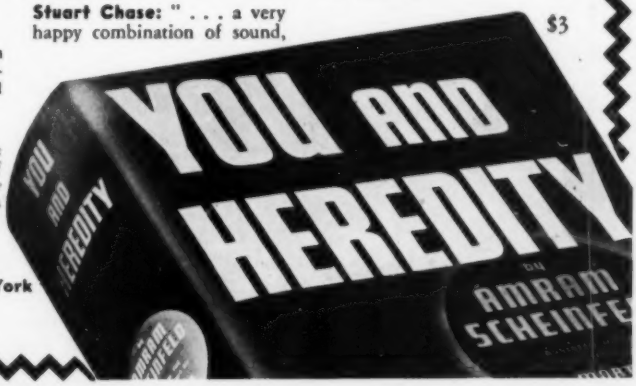

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